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Popular Mechanics

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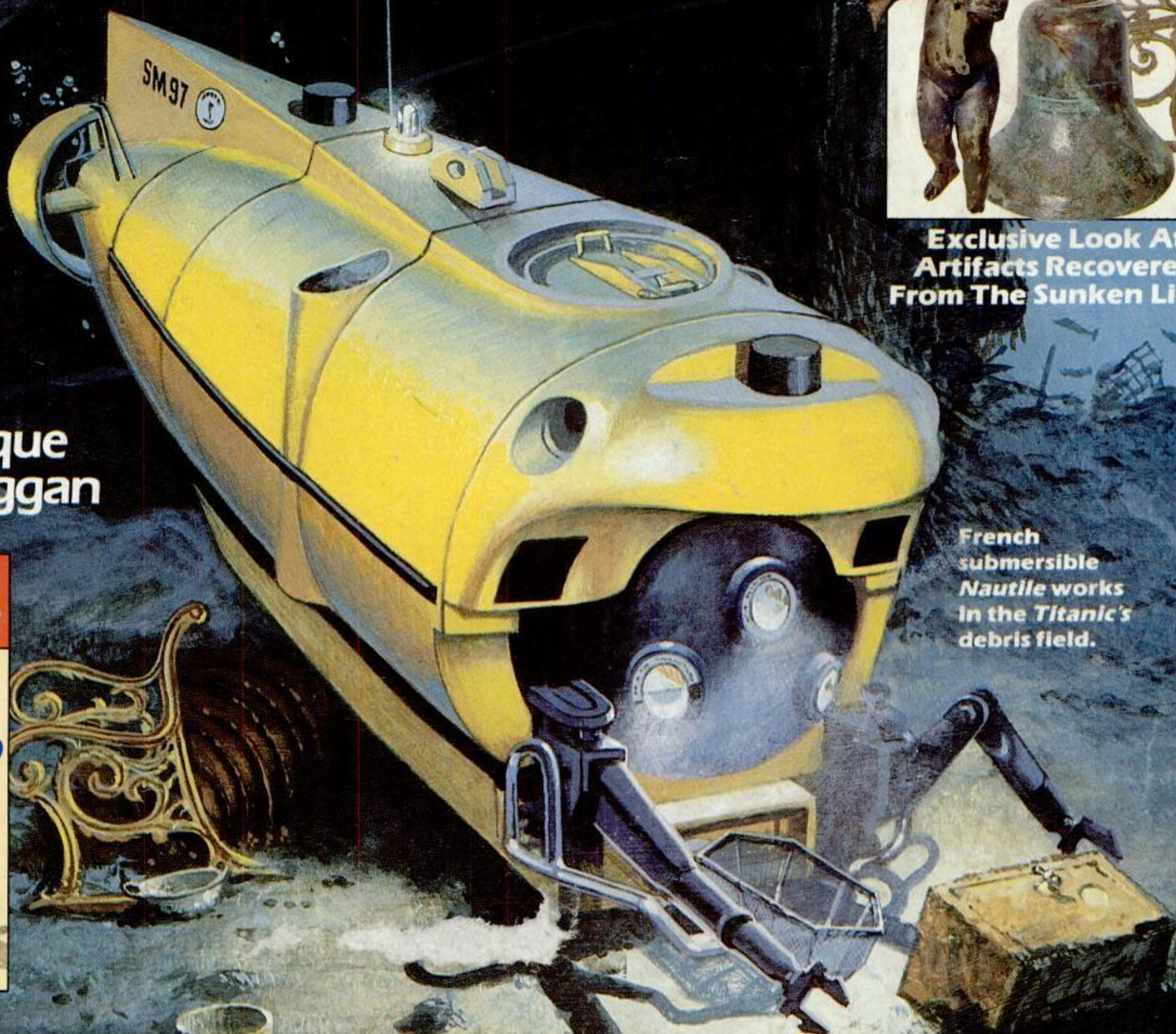
Inside Story Of The Stealth Bomber Plus The Advanced Tactical Fighter, LHX Helicopter, X-Wing And V-22

FIRST PHOTOS



Exclusive Look At Artifacts Recovered From The Sunken Liner

French submersible *Nautille* works in the *Titanic's* debris field.



TOM FREEMAN
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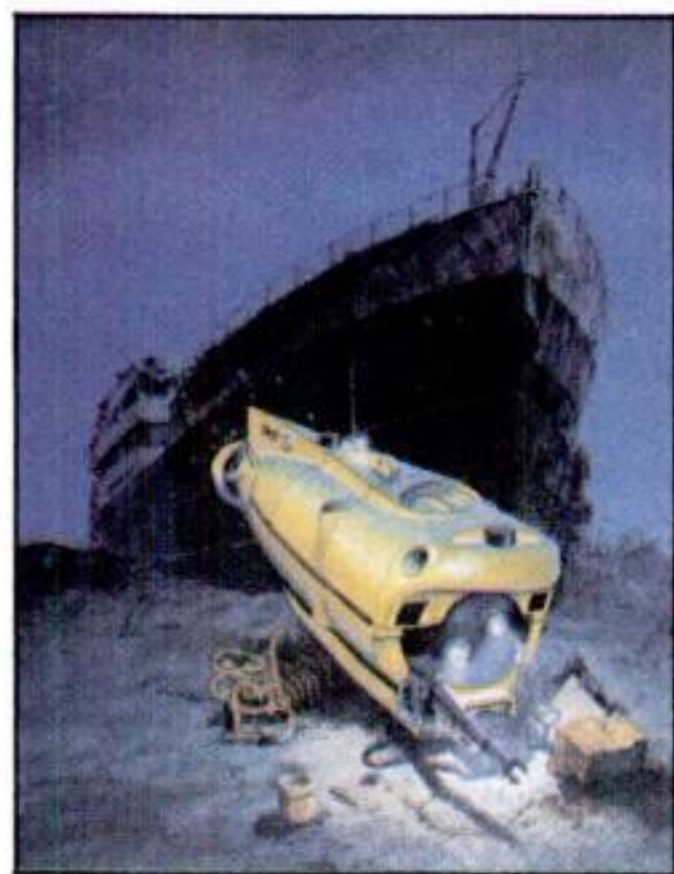
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64 COVER STORY

Was an iceberg the sole culprit on that starlit night of April 14, 1912? Or was the sinking of the *Titanic* the denouement in a gripping tale of chance and human error? To find out, marine engineers are relying on the state-of-the-art in submersible design. And we let you in on how they're retrieving the past.
—PM Illustration by Tom Freeman



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86 Snow speedster



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PM's Family Classics presents winter excitement with a sleek, new toboggan that's easy to build.

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WHEN news of the French *Titanic* expedition reached our offices, we had mixed emotions. There were those of us who agreed with Robert Ballard of Woods Hole Oceanographic Institute, the original discoverer of the *Titanic* remains, who felt that the site should remain untouched as a memorial to those who lost their lives in the tragedy. Others agreed with the French salvage team that the *Titanic* held riches beyond anyone's wildest dreams and it was up for grabs. Whatever we felt emotionally, we knew we had to cover the story. It was happening. It was news. And new technology was being used in the recovery of the treasures. Covering the story was one thing. Getting it into this issue was another. Fighting deadline pressures every step of the way, Science/Technology/Aerospace Editor Tim Cole and Graphics Director Bryan Canniff flew to Paris to supervise photography, gather information and discuss story slant with writer/reporter Sydney Rubin, then flew back on the Concorde. Meanwhile, our staff here in New York was preparing technical illustrations, beginning layouts and editing the text, which arrived from Paris via transatlantic computer hookup. It all finally came together and I hope you think the effort and expense was worth it. . . . **Being an auto editor** here at POPULAR MECHANICS isn't all pencil pushing. Case in point: When we decided to test the big, full-size pickup trucks for this issue, we wanted to test their handling with the cargo bed empty and with a full load. So we bought a 1/2-ton of railroad ties. First thought was to band them together and move them from truck to truck with an engine hoist. The hoist buckled and broke under the load on the first try. The only thing our expeditious editors could do was move a 1/2-ton of railroad ties *by hand* among five test trucks. And you thought all our editors did was attend press conferences in Palm Springs and sip strawberry margaritas by the pool. . . . **From time to time,**



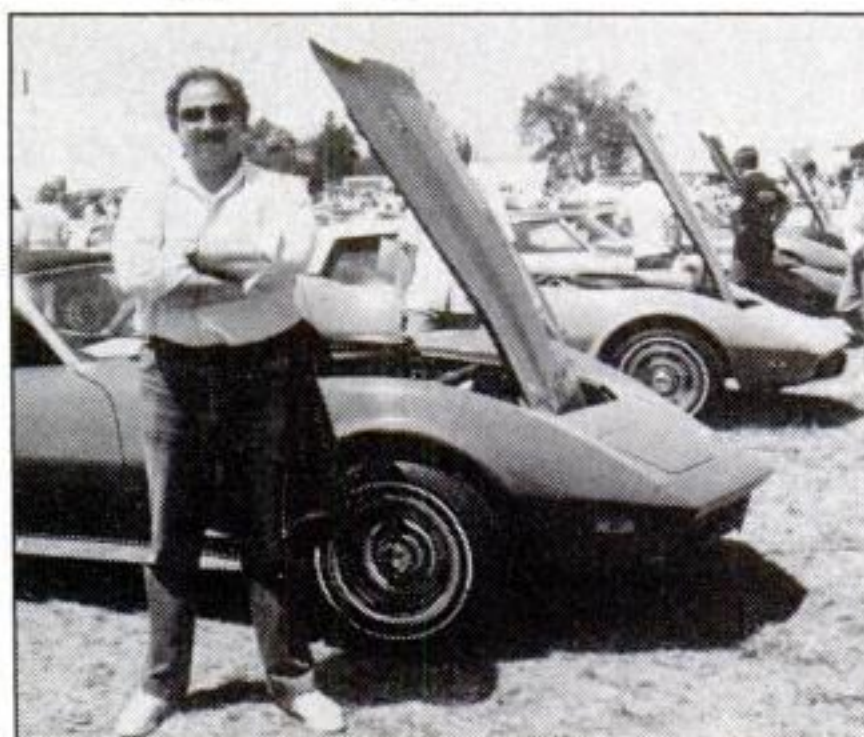
Canniff and Cole in Paris.



Auto editors at work. And you thought that it was a glamour job.

I've mentioned the Bloomington Corvette meet in this column. If you're a Corvette lover, which I am, it's like being the proverbial kid in the candy store. I was there this year with Contributor Cliff Gromer, whose real job is Editor of *Vette* magazine. Since Gromer is an acknowledged expert in this field, I asked him to write our Bloomington story, which you'll find under our "Freewheeling" heading in this issue. . . . **There's something else very special** in this issue of POPULAR MECHANICS. It's a pull-out wall poster that we had designed to accompany our story on America's future air power. The illustrations in the story and on the poster, by top aviation artists Attila Hejja and Ted Lodigensky, incorporate every detail we could discern about the aircraft, most of which are still classified top-secret projects. If you like the idea of this bonus, let me know. We'll do more posters for you if enough readers like them. . . . **We've also revived our "Family Classics" project** series in this issue. Home & Shop Editor Steve Willson came up with a classic toboggan for you to make that could become a family heirloom. It's that beautiful.

'Til next time.



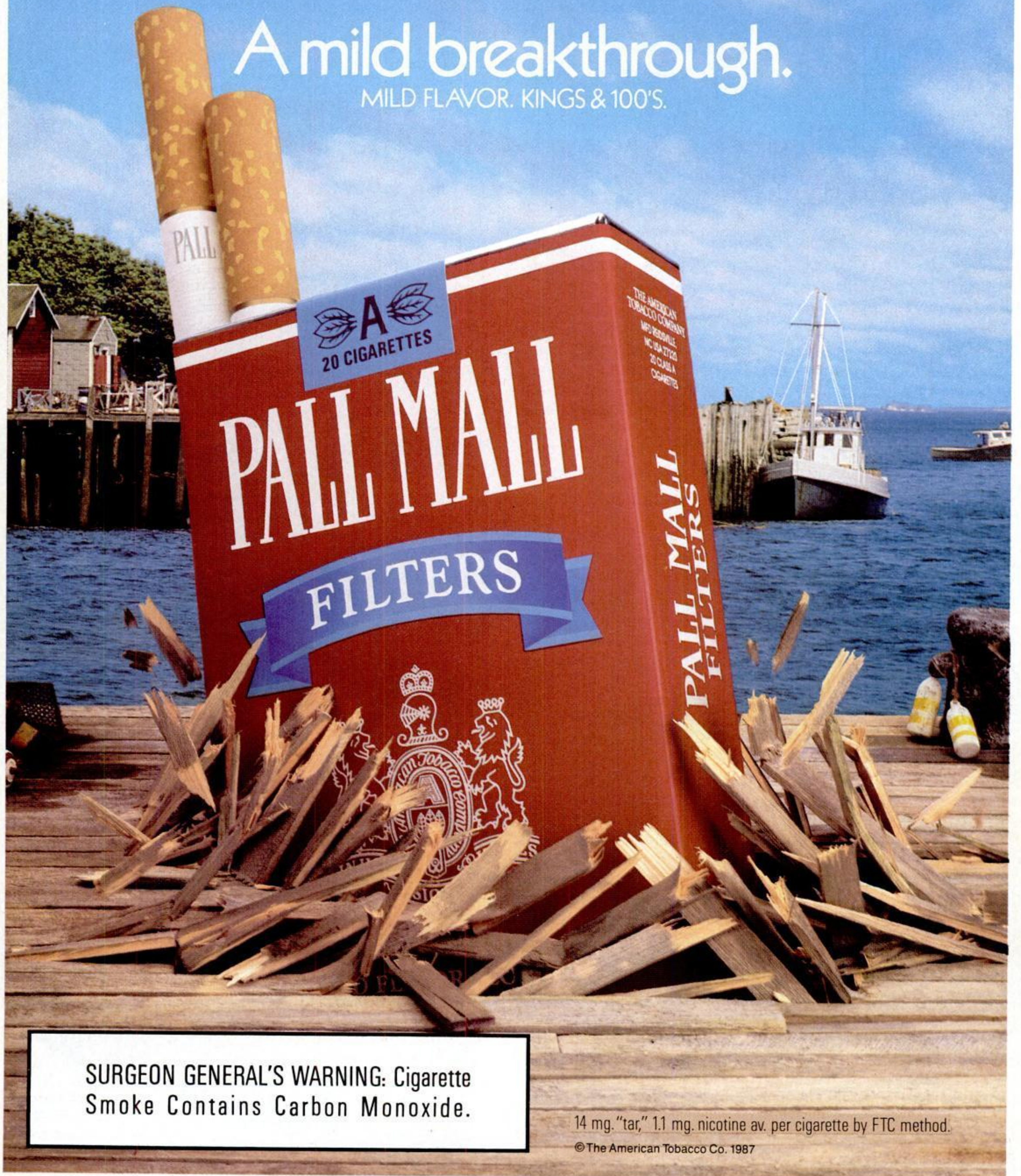
The proverbial kid in the candy store.

Joe Oldham
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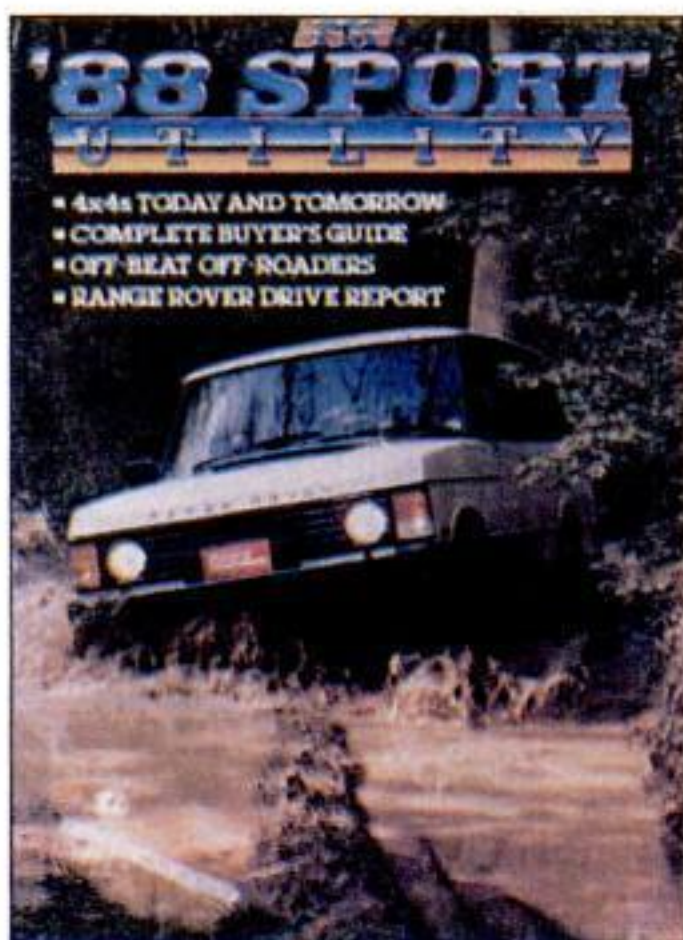
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LETTERS

Range Rover Versus Jeep: What Price Off-Road?

BEFORE you say that the Range Rover is a 1-of-a-kind vehicle, or the "Rolls-Royce of sport utility vehicles" or "king of the off-road," ("Drive Report: Range Rover," page 94, Sept. '87), you'd better compare it to U.S.A.'s No. 1, off-road, luxury, 1-of-a-kind KING—The Jeep! Look at the price: \$31,900 for the Rover. I paid \$19,999 for my Grand Wagoneer. For an extra \$1200 I bought a 5-year, unlimited mileage warranty for service anywhere in the U.S. Does Range Rover have such a plan? Is Rover's 3.5-liter V8 as smooth and responsive as a Jeep's 5.9-liter? You say the Range Rover can cruise at 100 mph. Who has to go that fast? You indicate that



Range Rover muddies through on cover of Sport Utility Special Report in September. Chevy Blazer was on cover of issue.

possibly 90 percent of Range Rovers never leave the pavement. I'd be interested in the Jeep's ratio of off- and on-road travel. I'm probably a perfect example

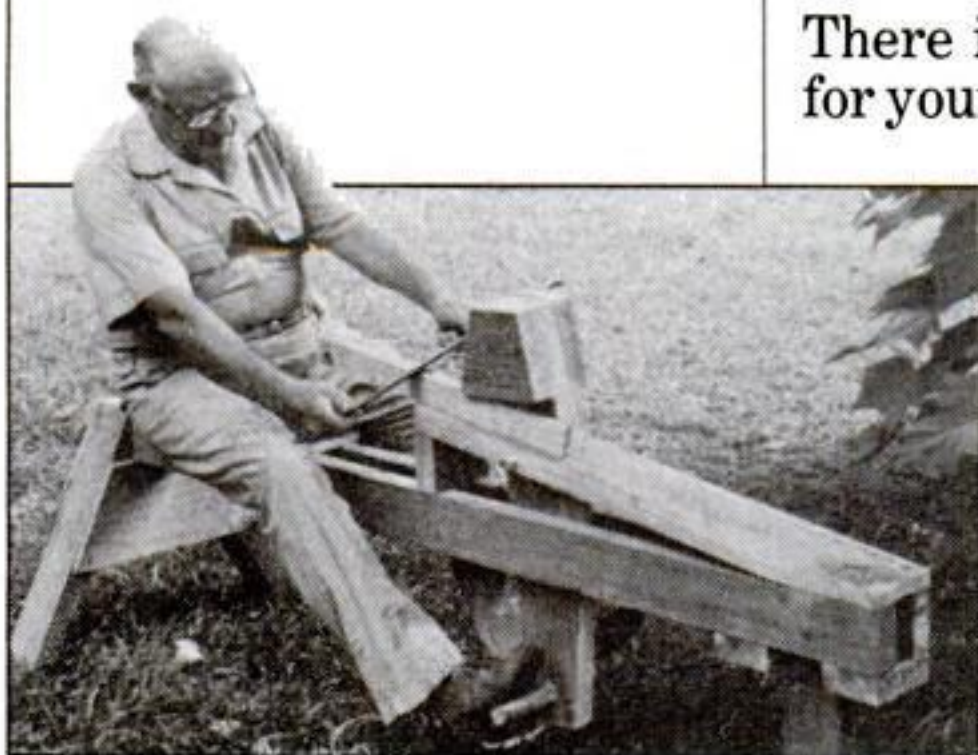
of why a person would buy a Range Rover or Jeep for all-around use: I'm a real estate agent and part-time rancher. My ranch has 100 miles of dirt roads and 9 miles of sandy beach. For my real estate work, I need a comfortable and luxurious vehicle for driving clients to the various properties. I'm not a Jeep fanatic, mind you, but mine sure does the job of handling off-road and highway assignments equally well. As a little postscript to this, my first letter ever to a publication, on the day I received your September issue I closed a real estate deal with, ironically, a Rover dealer who had been trying to sell me a Range Rover. No deal.

RICK SAWYER
LOMPOC, CA

Your September issue is ablaze with vehicular mistreatment. Starting with the cover of the issue showing the Chevy Blazer spinning its wheels with sand flying from underneath. Idiotic! Crazy! And the ad on page 2 has a vehicle flying 4 or 5 ft. off the ground as if cresting a hill at a tremendous rate of speed. Stupid! After 30 years in the vehicular maintenance repair shops of the Baltimore City Fire Dept., I'm especially sensitive to what such abuse can do to perfectly good machinery. These images don't promote sensible driving, and don't reflect the special care that most PM readers give their cars and trucks, I'm sure.

ALBERT J. JUSKUS
BALTIMORE, MD

Jimmy's Bench



Denning's shaving bench built from photo.

I've owned a draw knife for many years, but never really used it or appreciated its versatility—not until I saw your article and photos of former President Carter building his hickory chairs ("Jimmy Carter, Craftsman," page 73, Aug. '84). What I didn't own was a shaving bench that's essential for the knife's use, so I copied the President's bench using nothing more than the photo in your story. Now I'm ready to make those terrific chairs.

ELLIS H. DENNING
PINEVILLE, LA

Aluminum Wiring Update

There is an update needed for your article in "The Better Home" on aluminum wiring ("How To Defuse The Hazards Of Aluminum House Wiring," page 107, Aug. '87). The Underwriters' Laboratory standard for splicing wire connectors to be used with aluminum wiring was upgraded early this year, but when your August issue came out no wire nuts had yet been submitted for testing. So, while it may be possible to buy old wire nuts, they won't be in compliance with recent UL standard 486C. Copper-to-aluminum connections can be made using a specially designed crimping tool and the special compression-type connectors listed for this.

JOSEPH T. PONESSA, PH.D.
HOUSING AND ENERGY
RUTGERS COOPERATIVE
EXTENSION

Penultimate Letter

Nice article on Leo Loudenslager and his Laser 200 aerobatic plane in October ("High Roller," page 66). Having seen Leo perform, I agree he is probably the best. However, your caption under his photo in "Editor's Notes" (page 4) was unfortunate: You call him "penultimate" pilot which labels him as second best. Penultimate means next to last. It's a neat word and too many journalists think that if "ultimate" is great, "penultimate" is *really* great. It would show a lot of class—and maybe a bit of humility—to print a clarification.

WILLIAM J. BRANDEL
FAIRFAX, VA

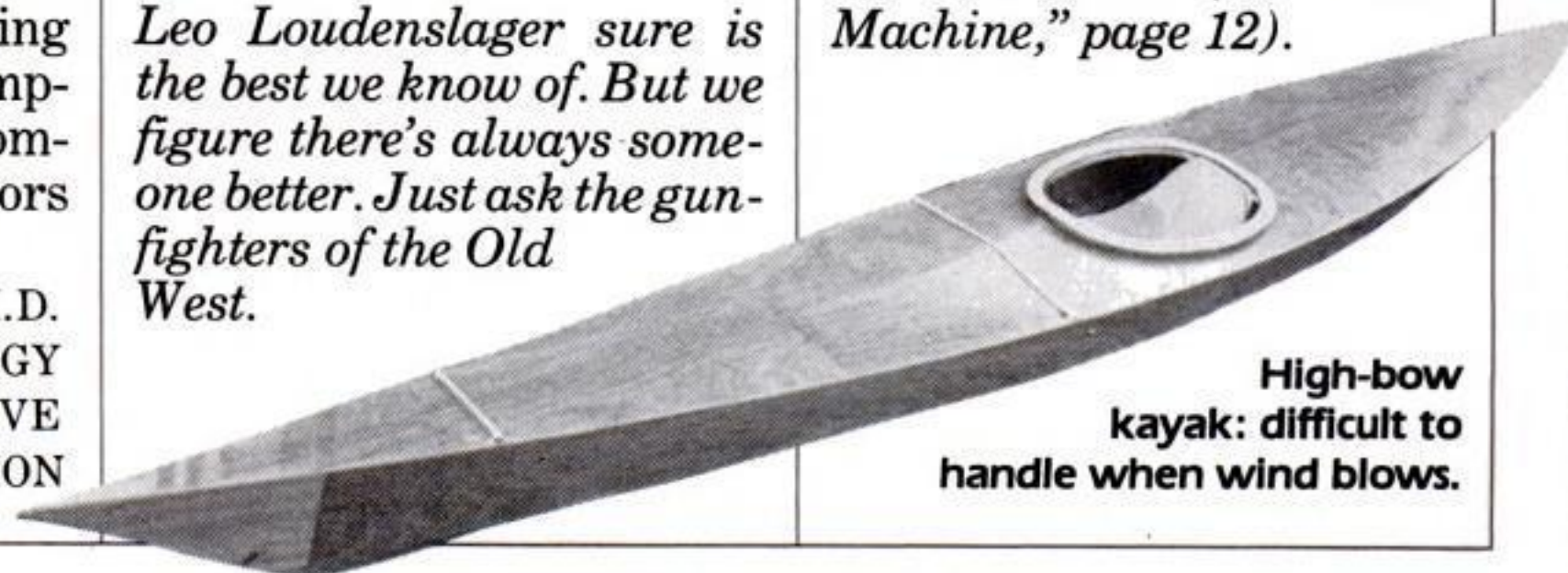
Leo Loudenslager sure is the best we know of. But we figure there's always someone better. Just ask the gun-fighters of the Old West.

Kayak Tip

Although rakish in appearance, John Lockwood's eskimo-type kayak ("Outdoors," page 37, Sept. '87) has a serious drawback: The high bow will catch the wind and act as a weather-vane. My father, who started building kayaks in 1890, built one from an eskimo kayak in Harvard's Peabody Museum. It looked exactly like Lockwood's. It performed excellently on calm days, but on windy days the bow went downwind. Latest kayaks have very low bows to avoid this.

WILLIAM A. SHURCLIFF
CAMBRIDGE, MA

For more nostalgia, don't miss the Indian canoe that appeared on PM's December 1912 cover (see "Time Machine," page 12).



High-bow kayak: difficult to handle when wind blows.

Popular Mechanics

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CAR CLINIC

BY MORT SCHULTZ

Undiplomatic Gesture

THE 318-cu.-in. V8 engine of my 1987 Dodge Diplomat has a rumbling noise that's heard in the car as I drive along. The dealer put a weight (part No. 4412542) on the exhaust system to get rid of the vibration without success. Now he tells me all Chrysler V8 models have the same problem. I realize it's tough to diagnose noise without driving the car, but I'd be grateful for any clues. I have an ear problem and driving this car is painful. I'll have to sell it if the situation isn't resolved.

ERVIN HEMSHROT
WASECA, MN

The dealer had the correct repair part (No. 4412542), but he installed it in the wrong place. If your car is like other rear-wheel-drive, Chrysler-built cars and light trucks, the noise is not originating with the exhaust system, but at the transmission housing extension. That's where the weight should go—on the rear of the extension. Your dealer may not have put the weight there, because he probably found one already there. But that one should be discarded in favor of a new weight (part No. 4412542) and plate (part No. 3681614). Mounting screws should be tightened to 150 in.-pounds.

If the noise does originate with the exhaust system, then check for clearances with the car sitting on its suspension and someone sitting in the driver's seat.

One Of A Kind

The tires on my 1983 Ford EXP are 165/70/365. When I went to buy new tires, I was told that only one manufacturer makes this size. Is this true? Is there another size I can substitute?

CECIL E. SANDERS
INDEPENDENCE, MO

Yes, it's true. The only manufacturer that sells this metric-size 165/70/365 tire in the U.S. is Michelin. Called the TRX by Ford, this wide, low-profile tire and wheel assembly is part of the EXP optional high-performance suspension package. Sizes you can substitute safely are P195/60/14 which has a load rating of 85 and P175/70/14 which has a load rating of 84—more than the 165/70/365, which has a load rating of 81. Obviously, you have to buy new wheels since those you have now measure 14.3 in. (365 mm), and the substitute tires require 14-in. wheels.

However, Ford developed the suspension tuning on TRX-equipped cars to take advantage of the TRX tires' unique, cantilevered sidewall design. You may find that handling and especially the ride suffer because of the substitution.

TV Interference

A weird problem has arisen with my 1982 Pontiac 6000

which is outfitted with the L-4 engine and 125C automatic transaxle. On occasion upon starting the engine, the accelerator pedal is hard to press and the transmission remains in First gear. The only way I can get it to behave again is to turn off the engine and wait a minute or so before restarting. The condition is more prevalent when the weather is cold. I've talked to a number of transmission shops and get no assurance that they know what's causing the problem, but for a healthy fee they are sure willing to look. Any clues, Mort?

CHARLES JANECHER
CEDAR RAPIDS, IA

I don't know what these guys are making such a big fuss about, Charlie, when the cause of the condition is undoubtedly lying with the throttle valve (TV) cable assembly or the throttle valve itself. It sure shouldn't cost a "healthy" fee to find out. Here's the way I suggest you

have the problem handled. First, clean and lubricate the cable from the carburetor right to the link connecting the cable to the TV plunger. Use a waterproof grease to prevent moisture buildup. Your problem could be caused by moisture getting on the cable. Then as the cable gets warm, the frost melts and the cable is freed. Check to make sure the cable is working freely. Do this by pulling on the end of the cable where it exits the transmission. The cable should offer light resistance over a short distance before you start to feel heavier resistance. The light resistance is caused by a small coil spring on the TV lever that allows the lever to pop back when the throttle closes. As you hit heavy resistance, release the cable. The assembly should spring back to the closed-throttle position.

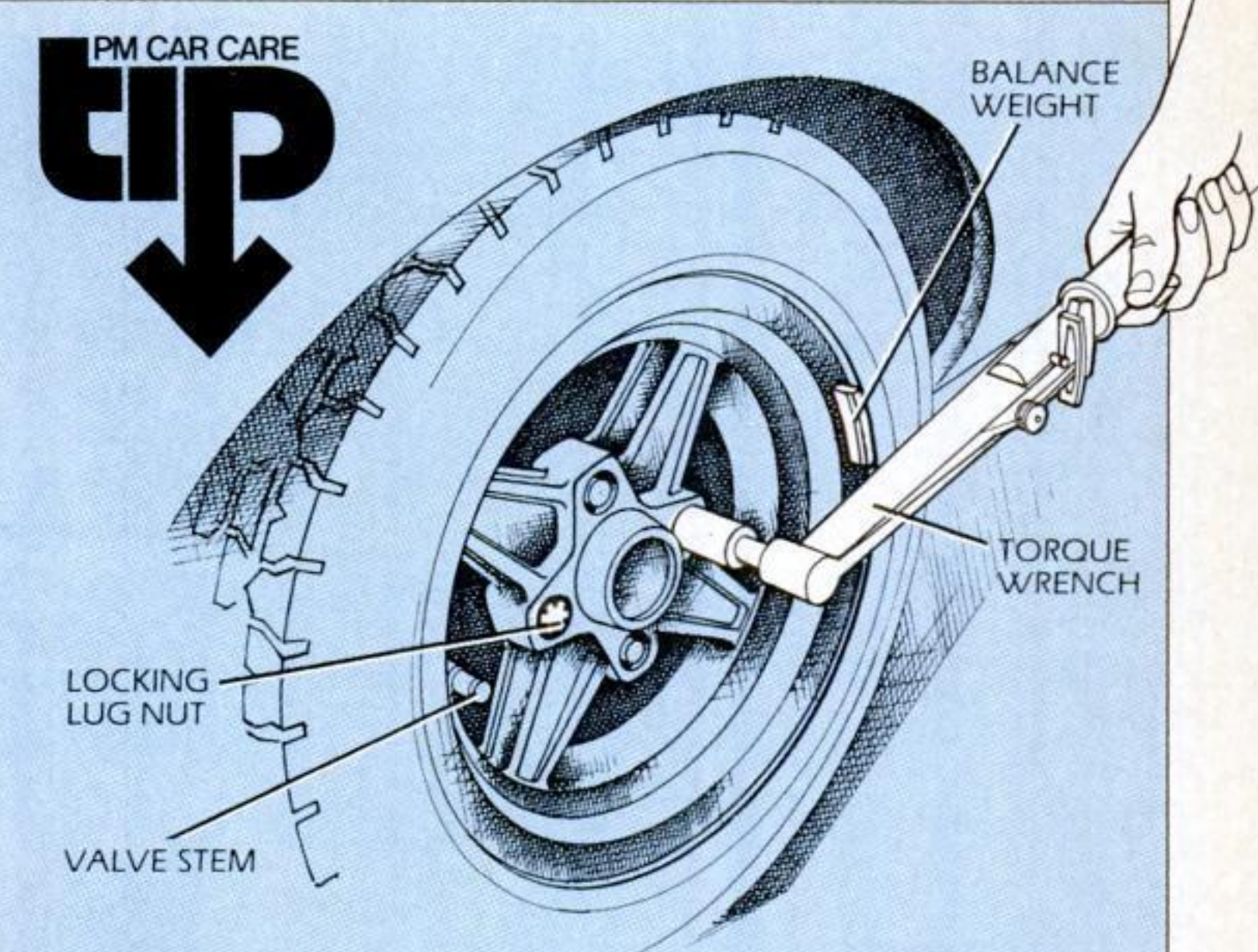
The cable adjustment should be tested by taking a line-pressure gauge read-
(Please turn to page 10)

Balancing Act

You've just bought a new set of mag wheels, and had tires installed at the dealership. Balanced, too, on one of those fancy computer balancing machines. The man running the machine guarantees the balancing job is good for as fast as you could make your car go.

They look good, but the vibration at any speed faster than that of a high-performance skateboard is enough to shake the fillings out of your teeth.

Don't blame the operator, or the computer balance job, either. Neither could know about the extra weight of the locking lug nuts you added. You'll probably need to have the wheels rebalanced while mounted on the car, but try adding a ½-ounce weight op-



posite the locking lug first.

Recommended procedure is to install the locking lugs nearest the valve stem, where the wheel is probably a little lighter and you will know

exactly where to reinstall them if the wheel is ever removed. Always lubricate the threads and chamfer with oil or grease, and torque to the recommended values.



Pure Joy

(And we'll deliver...tomorrow morning)*

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slip into a shirt pocket, beautiful enough to win an international design award — and advanced enough, thanks to its sophisticated Rashid-rejection circuitry, to obsolete the detectors of every other maker.

Then imagine finding one with your name on it.

Money
MAY 1987

Best Anywhere

Money magazine, May 1987, listed 99 Things That Americans Make Best. "All of these widely available U.S.-made goods...are clearly superior to their overseas competitors, overwhelmingly dominate their markets or are so outstanding or novel that they have no well-known international counterpart."

This select list included PASSPORT.

PASSPORT has exactly what the discerning driver seeks; superheterodyne performance with complete Rashid rejection. On duty, it maintains a commendably low profile, only 0.75 inch tall. It's about the size of a cassette tape.

An instrument providing so much protection always elicits the same response...Pure Joy.

Others may put it differently. In April, *Car and Driver* tested nine of the latest radar detectors. Once again PASSPORT was rated highest. These magazine experts said, "At \$295 direct from the factory, it's the most expensive piece of electronic protection in the group, but it's worth every nickel in roadgoing peace of mind."

This good reputation keeps getting better. In June, the *Roundel* ranked PASSPORT first in a comparison of 14 detectors, saying, "It remains the State of the Art, a true quality product, American ingenuity at its best."

Installing PASSPORT is easy. Just clip to visor or windshield, plug into the lighter, and PASSPORT is on guard.

Pure Joy is also our commitment to you, the giver. If PASSPORT doesn't live up to your highest hopes — for any reason — within 30 days, just send it back. We'll refund all of your money and your return shipping costs. There are no hidden charges.



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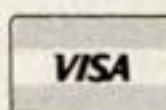
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CAR CLINIC

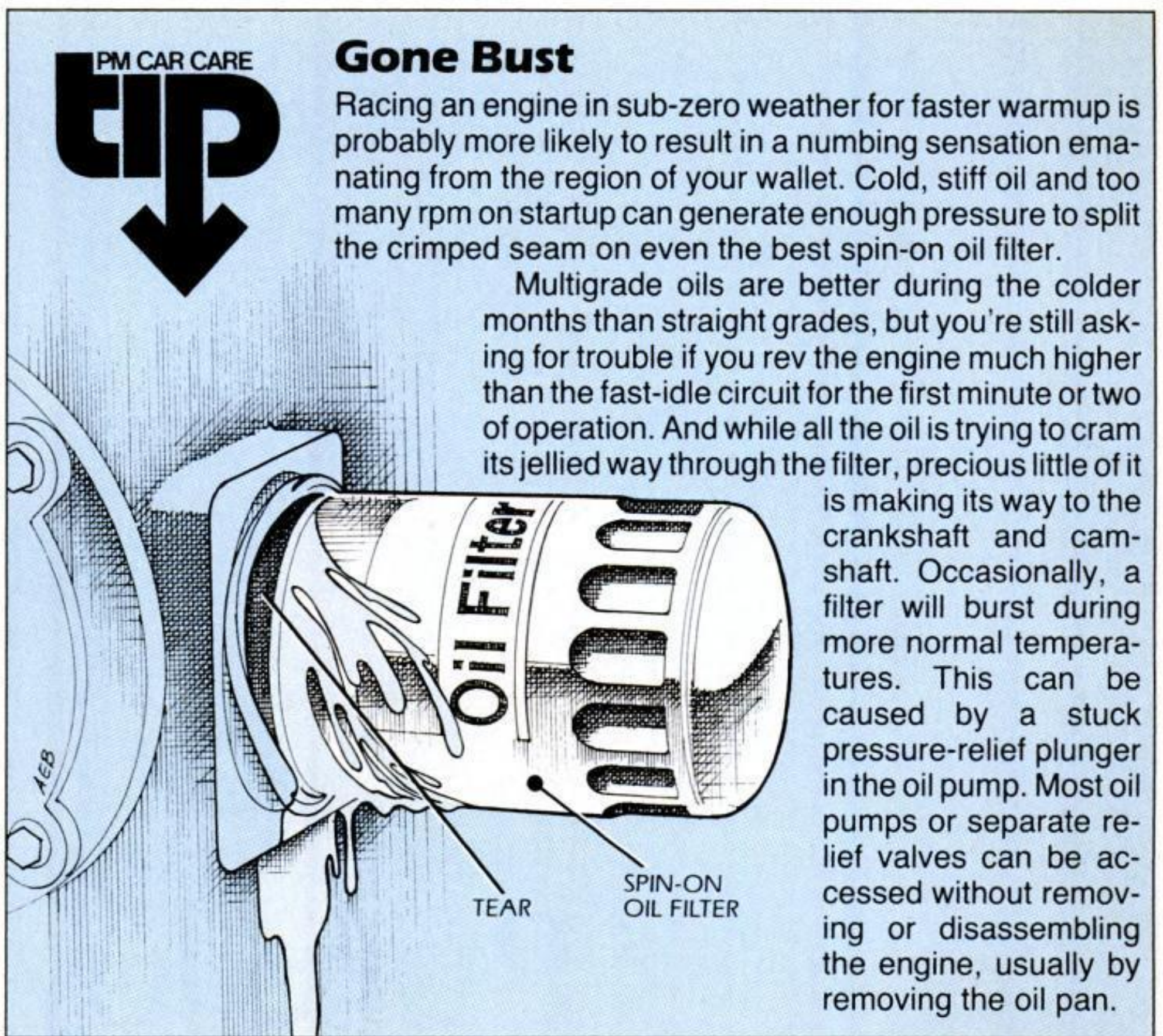
(Continued from page 8)

ing with the transmission selector in PARK and the engine running at 1000 rpm. Then, with the selector in NEUTRAL again at 1000 rpm. The pressure in NEUTRAL should be equal to or no more than 10 psi higher than the reading in PARK. Finally, as engine speed is increased to 1400 rpm, there should be an increase in line pressure.

If the pressure readings aren't this way, the TV cable should be readjusted to the specs in the service manual. If a misadjusted cable isn't the answer, then the trouble lies with a damaged TV lever/bracket assembly, TV spring, TV plunger and bushing assembly or the throttle valve itself. Even if the mechanic has to get inside the transaxle to change the throttle valve, there's no reason for a repair to cost a small fortune. It's easy enough to do just by taking off the pan with the transaxle still on the car.

Time Marches On

A member of our family has a 1985 Honda 3-door that has halogen headlamps. A year after he bought the car, a halogen bulb went out and was replaced by the dealer. Six months later the same bulb went



Gone Bust

Racing an engine in sub-zero weather for faster warmup is probably more likely to result in a numbing sensation emanating from the region of your wallet. Cold, stiff oil and too many rpm on startup can generate enough pressure to split the crimped seam on even the best spin-on oil filter.

Multigrade oils are better during the colder months than straight grades, but you're still asking for trouble if you rev the engine much higher than the fast-idle circuit for the first minute or two of operation. And while all the oil is trying to cram its jellied way through the filter, precious little of it is making its way to the crankshaft and camshaft. Occasionally, a filter will burst during more normal temperatures. This can be caused by a stuck pressure-relief plunger in the oil pump. Most oil pumps or separate relief valves can be accessed without removing or disassembling the engine, usually by removing the oil pan.

dead. We've been told that these bulbs are sensitive to moisture and contamination.

Does this mean there's a crack in

the headlamp itself that's admitting moisture?

B. WILLIAM VANORSDALE
ELKINS, WV

PLYMOUTH THE PRIDE'S INSIDE.

PLYMOUTH VOYAGER, NO. 1 IN OWNER SATISFACTION*, INTRODUCES GRAND VOYAGER WITH MORE ROOM FOR COMFORT, MORE CARRYING SPACE AND NEW V-6 POWER.

The Pride's Inside Plymouth Grand Voyager. Front-wheel drive • car-like handling • versatile seating for up to eight** • more room than Ford Aerostar • a choice of two fuel-injected engines: a powerful new 2.5 or dynamic V-6, either one makes towing simple • power

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*J.D. Power and Assoc., 1987 Compact Truck CSI/customer satisfaction with product quality and dealer service on 1986 models. **Seating for 8 available only on Grand Voyager SE with 3.0L engine, auto. trans. and front bench seat. †Protects engine and powertrain for 7 years or 70,000 miles and outer body rust-through for 7 years or 100,000 miles. See limited warranty at dealer. Restrictions apply. BUCKLE UP FOR SAFETY.

You say the car is an '85 and that the dealer replaced the bulb. Honda didn't adopt headlamps with replaceable halogen bulbs until the 1986 models. The year and a half over which events have taken place puts the date of the car's purchase at about February '86, so it is, indeed, a 1986 model.

There could be a crack in the headlamp housing but more likely there's a bad gasket between the lens and reflector. Is there moisture collecting inside the lens?

There are three conditions that cause halogen bulbs to burn out prematurely—dirt, vibration and excessive voltage. Dirt comes about by careless installation. Fingers are the culprit. Contamination (grease, sweat) gets on the bulb and causes a hot spot that leads to a burn-out. If this is the situation, you'd see a cloudy spot on the glass of the failed bulb. Handle a new bulb with a tissue or clean rag. If you do accidentally touch it, wipe it with lacquer thinner or alcohol.

Is the car driven over rough roads? If so, vibration could be the reason for recurring failure. If the element is broken into two clean ends, that's vibration damage.

The last reason why a halogen bulb fails, excessive voltage, is indicated by the ends of the broken element being

black. DC-voltage output should be between 9.5 and 13.5 volts. If it's more, the voltage regulator becomes suspect.

Knock Worst

At about 20,000 miles, my 1984 Dodge Daytona Turbo developed a knocking or tapping sound at lower speeds. The dealer says it's fuel-injector knock. If there is such a thing, is it detrimental to the engine or turbo?

LARRY HARRISON
PAGE, AZ

There is such a thing as a noise from the fuel-injection system of this car, but not from the fuel injector. Even if fuel injectors made noise, it's not loud enough to be heard inside the car.

But it is a fact that '84 Chrysler engines with turbos have had fuel pressure regulators that sound off and can be heard.

To silence matters, have a damper package (part No. 4203640) installed, but if you don't want to that's okay. No harm will be done to the engine, injection system or turbo.

FM

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

■ If the 1.9-liter CFI engine in your '87 Escort, EXP or Lynx is hard to start or lacking power, where do you look to find the problem? The underside of the wire harness which supplies current to the air temperature sensor and fuel injector. The harness rests against the rocker cover. If the wires have been chafed so they're grounding out, they should be taped and covered with convoluted tubing. So says TSB 87-11-16.

■ If you aren't pleased with the performance of the defroster in your '87 Toyota Camry, you'll be happy to learn of a new defroster nozzle deflector plate (part No. 55957-32010) that heats things up. Your dealer now has it.

■ If your '87 Buick 2-liter turbo engine misfires under hard throttle conditions, the cause is probably rooted with the high-gap (0.060-in.) sparkplugs not being able to meet demand. That's why you should switch to an AC R42XLS (0.035-in.) plug or equivalent. The switch is okayed by Buick TSB 87-6E-18.

■ Chrysler has pinpointed why the '85 2.2-liter, 2-barrel carbureted engine that's coupled to a manual transaxle in an L-body car surges or bucks under light throttle. The L-body is the designation for Horizon, Turismo, Charger and Omni. Installing a new driveability kit (part No. 4419445) as described in TSB 18-15-87 will allow the slightly richer fuel mixture needed to put a stop to this annoyance.

VOYAGER



PLYMOUTH GRAND VOYAGER LE

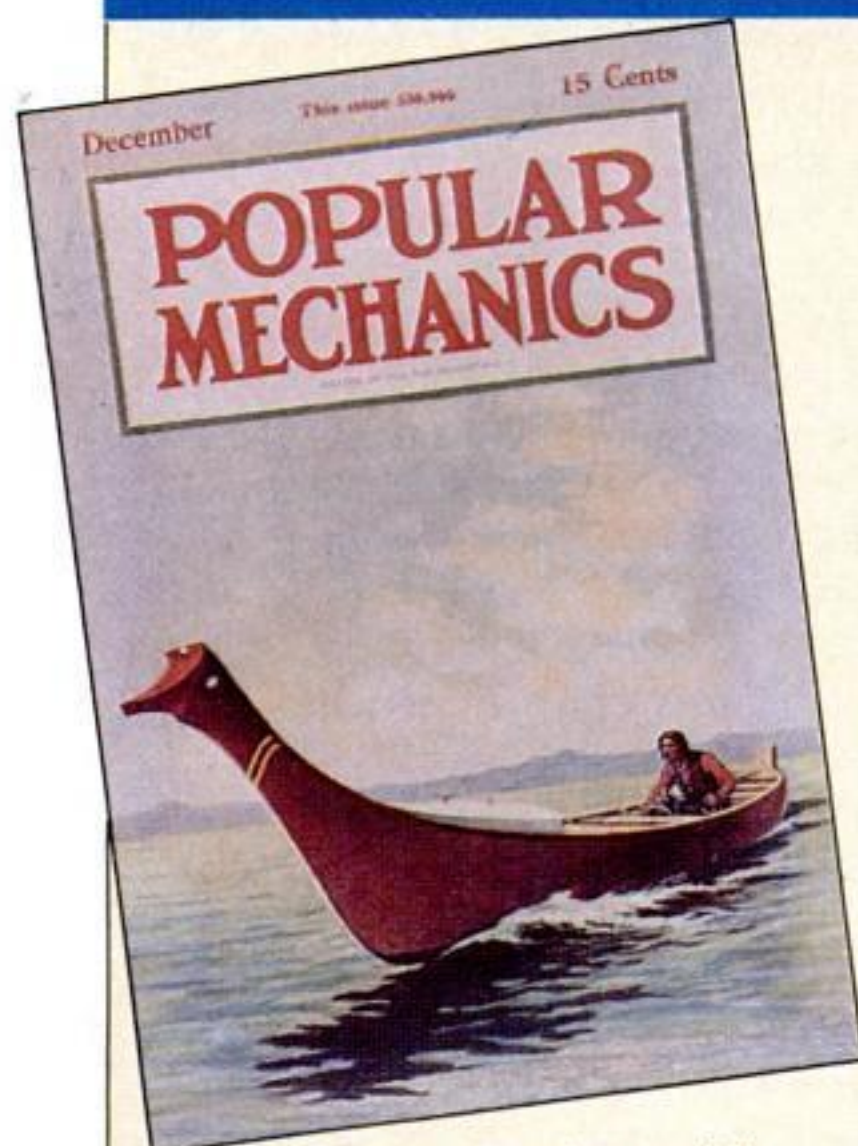


7/70

Division of Chrysler Motors

TIME MACHINE

75 YEARS AGO: December 1912



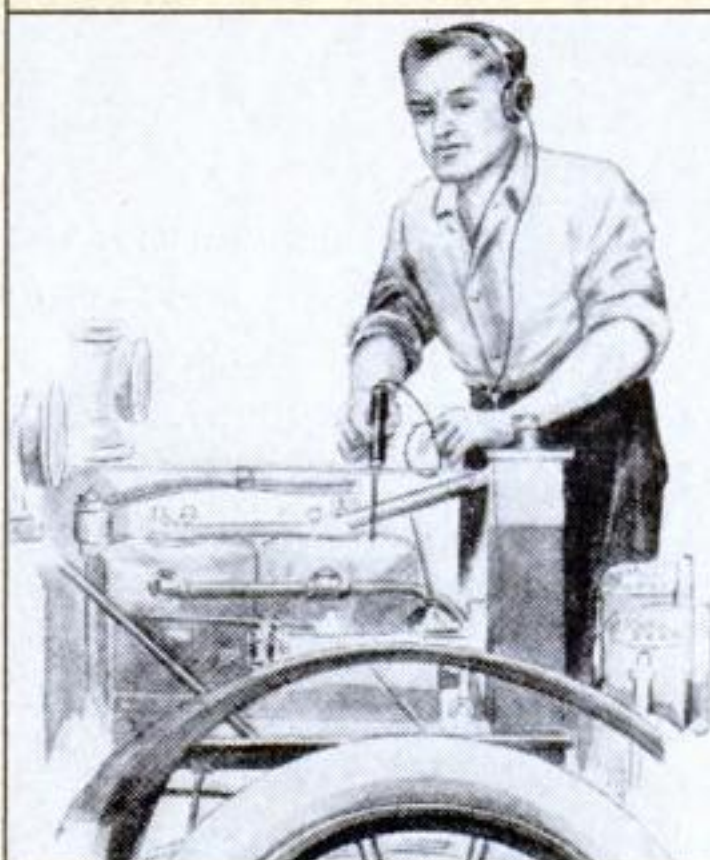
Replacing the paddle.

Motorized

The march of technology affected virtually everyone in the early 20th century, including, as PM pointed out, the proud North American Indian. Our cover 75 years ago illustrated an industrious native American piloting a gasoline-powered dugout canoe. The accompanying article revealed how Indians were discovering the power and simplicity of internal combustion. The result? Indians along Puget Sound were literally throwing away their canoe paddles.

Listening In

Elsewhere in PM's December 1912 issue, we reported



Finding faults—acoustically.

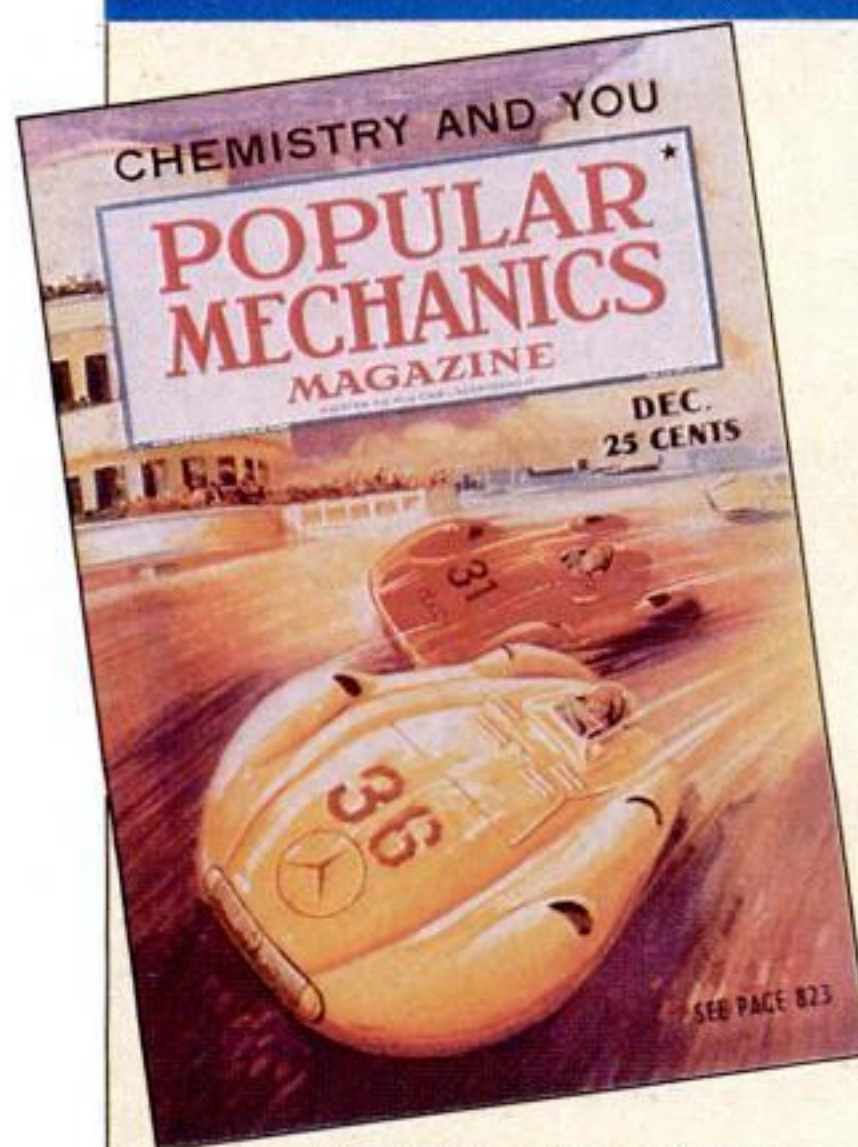
on the cross-fertilization between emerging technologies. Auto repair was a case in point.

Doctors had long used the stethoscope to listen to their patients' internal organs. The "autoscope" was fashioned from a microphone and a telephone receiver headset.

Consciousness-Raising

What would be the scourge of mankind in years to come? PM's prediction: The unchecked emission of smoke into the atmosphere.

50 YEARS AGO: December 1937



Speeding into history.

Without Wrinkles

POPULAR MECHANICS suggested 50 years ago that the European racing circuit was the cradle of automotive streamlining. In their quest for optimum drag coefficients, German Auto Union engineers were developing race cars that routinely topped 225 mph. Tires were still narrow, and rear-end downforce wasn't a concern. But if speed was more important than control, these sculpted wonders were the way to go. Automotive aerodynamics is still a major focus.



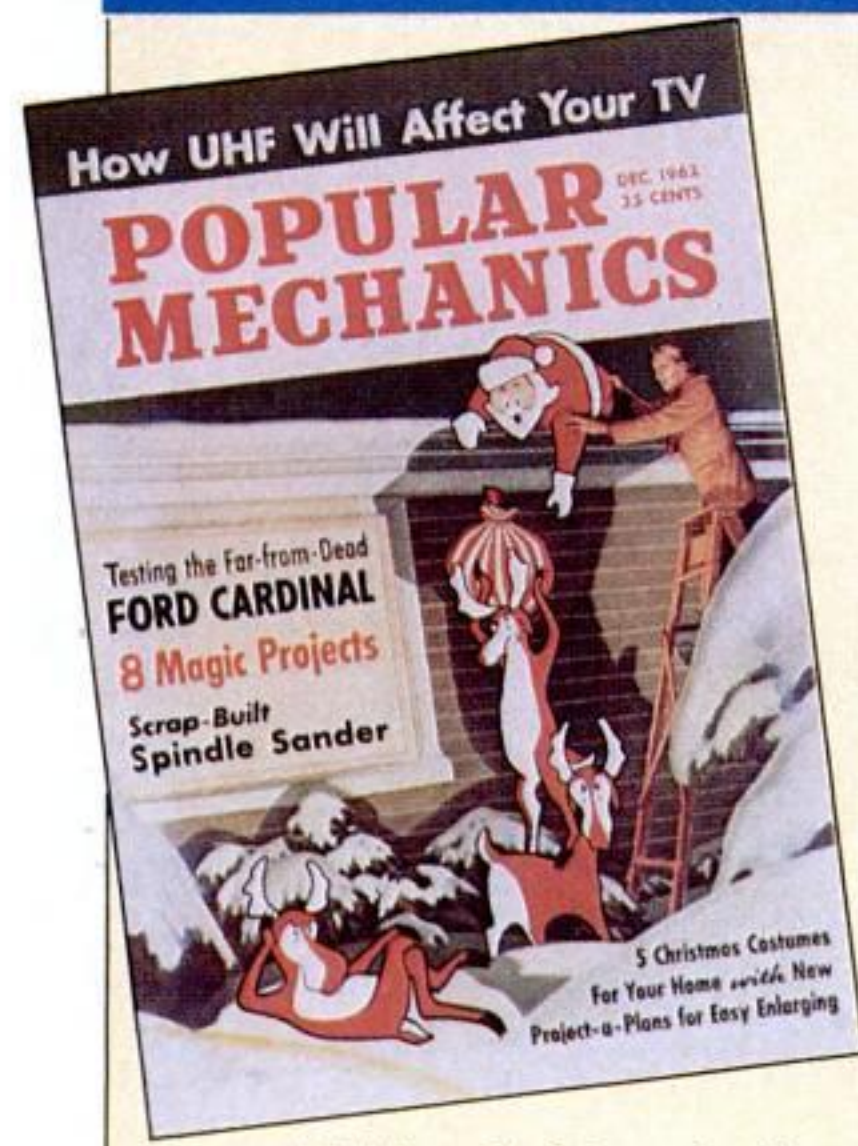
Hauling a house coast-to-coast.

RV Trike 3-Wheeling

Add to Depression-era stunts like flag-pole sitting and dance marathons this coast-to-coast endurance ride aboard a trike-and-trailer camper. The minia-

ture house on wheels had a bed, radio, running water and tiny galley, all packed in a compartment 7 ft. long and 4 ft. wide. A 1-hp engine drove it at a sprightly 30 mph.

25 YEARS AGO: December 1962



Making Christmas festive.

'Twas The Season

To ring in the holidays, PM's cover of 25 years ago showed readers how to build Christmas-theme dioramas. Plans included in the issue consisted of simple 35mm line-drawing cut-outs that could be enlarged and duplicated using a standard slide projector. A winter wonderland of plywood and paint was the final result for PM's growing legion of do-it-yourselfers.

Glass Technology

Fiberoptics. Gun stocks. Pole vaults. They were just

some of the myriad uses being found for glass back in 1962. Some items, like the trichroic-coated lenses in the eyeglasses pictured, were the embryonic begin-



nings of heads-up displays found aboard today's fighter aircraft.

New In '62

A provision for a UHF channel on all new televisions was stipulated by law. So PM took a look at the full picture with a report on UHF's impact on still-traditional VHF reception. Elsewhere, we covered a new floating heliport, the latest strides in motorhome design, and a TV tower 200 ft. higher than the Empire State Building. **PM**

Seeing into the future.

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IMPORTS

BY BILL HARTFORD

Plastic-Bodied Roadster Joins BMW Fleet

It could be a lifeboat for BMW's 12-cylinder 7-Series flagship. Actually, the Z1 is the kind of car that makes stuffed shirts jump ship, and ditch their pin stripes, too. The little roadster is going from prototype to production model, with six a day scheduled to come off the line, initially for the European market. Like the Fiero, the 153-in.-long 2-seater has a steel chassis



BMW's Vette: Thermoplastic Z1 2-seater gets 170 hp from 325i's Six.

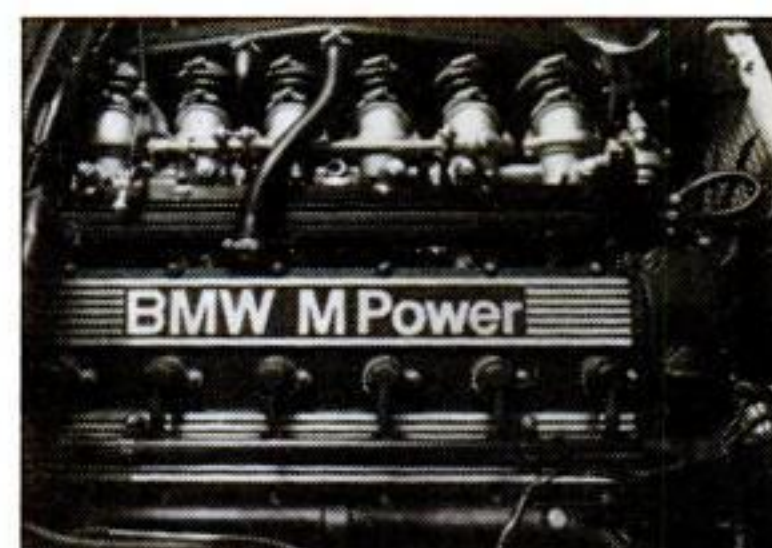
and composite body panels—in this case, Xenoy, a new G.E. thermoplastic. Unique to the Z1's design are the doors, which slide down into the tumble home of the massive rocker panels. You can even drive the car with the doors

“open,” elbows out, just like in an old Triumph TR3. Amazingly, BMW's 170-hp, inline 2.5-liter Six slides under the hood, way aft so weight distribution is a sure-footed 50/50. With the power going to the rear wheels, the roadster sees 60 mph in 7 seconds and has a top speed of 140. Yes,

there's a roll bar: It's integral with the windshield frame. On the header are the same easy-to-snap latches that BMW uses with its 325i convertible, and the top also hides behind the seats. The Z1 is as open and fast as 4-wheelers get. If it's still not sporty enough for you, BMW also makes motorcycles.



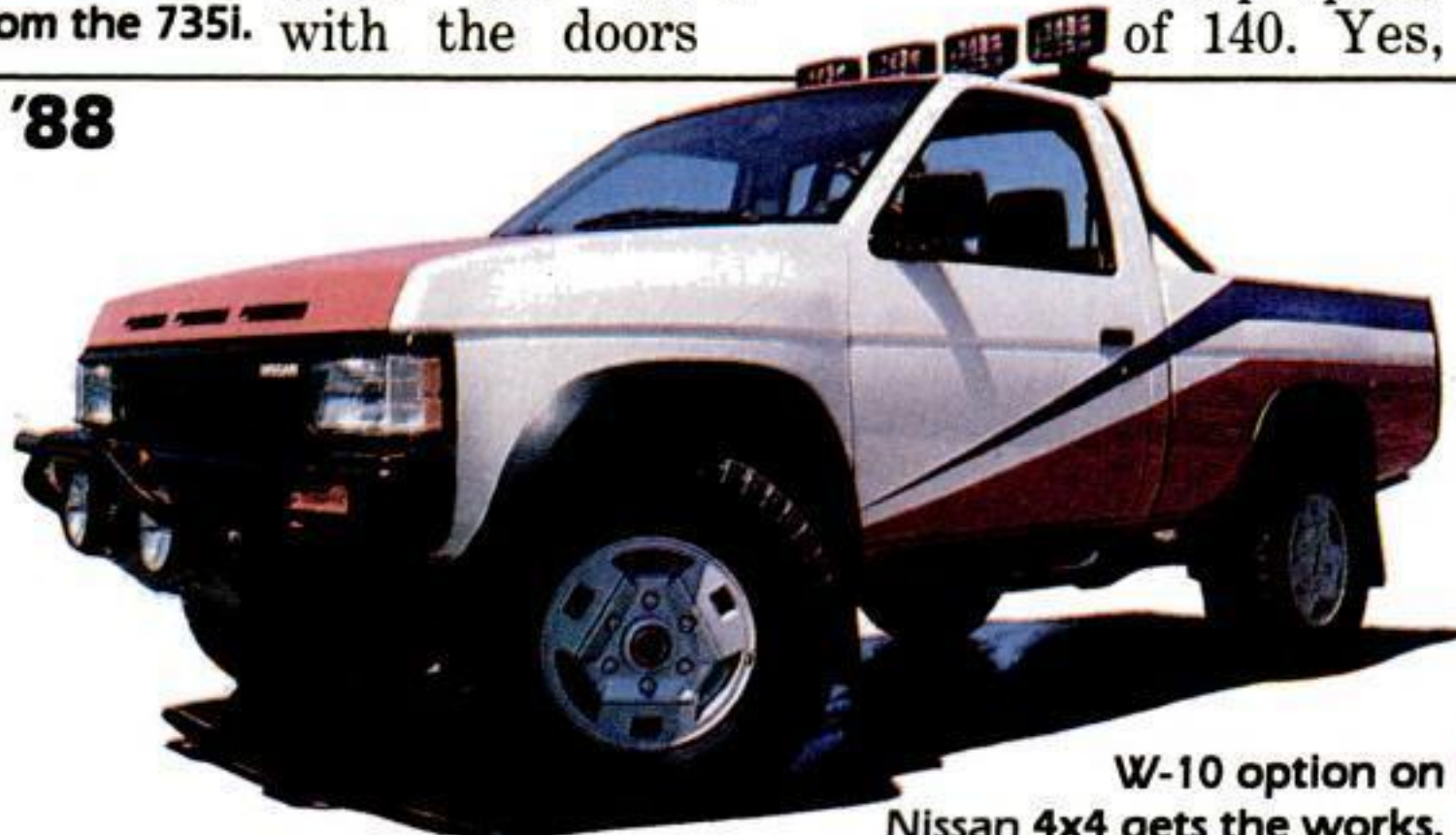
New 5-Series takes styling cues from the 735i.



BMW's hottest: M Power Sixes.

Nissan Trucks Into '88

It looks like Nissan held its own Customize-This-Truck contest, just as we did recently when we awarded a 4x4 King Cab SE to Larry Wood for his sports-truck design (see “We Have A Winner,” page 99, July '87). The W-10 isn't a 1-off, though, it's a showroom-ready, limited-production version that highlights the Nissan truck line for '88. For starters, the 3-liter V6 is up 5 hp. The 4x4's exterior waves at you in red,



W-10 option on Nissan 4x4 gets the works.

white and blue, and bristles with beams on the light bar. Limited slip, skid plate and off-road bumpers keep you bouncing along. At the wheel you'll

discover the upgraded interior and tinted glass. Add an ice-chest holder and a bed mount for the spare and you're ready for Baja. All pickups, whether 4x4, 4x2, Standard, E, XE, Regular Bed, Long Bed or King Cab, get the bold nose of the Pathfinder. This designed-in-L.A. “ute” has a 3500-pound towing capacity for '88. The Van, gets dual air conditioning in its

XE and GXE. Among passenger-car refinements are fuel injection for Sentra 1.6, 16-valve 1.8 for Stanza, a horsepower boost for 300ZX and Sonar Suspension for the Maxima. A sensor “reads” the road and



Baja bound: Spare's in the bed.



Pulsar NX, seen with Sportbak wagon module, gets 16-valve 1.8.

adjusts suspension accordingly. During our smooth test drive, even over washboard and potholes, we concluded it's the perfect automatic system—because you can't tell it's working!

Biggest Mazda

The 929 just rolled onto the big-car battleground first occupied by Honda's Acura division. Elegant, but conservative, the 929 is now squaring off with the Legend. Soon, it will have to take on two more “prestige” models: from Nissan's

Infiniti division and Toyota's Lexus. The 929 totes lots of ammunition—3.0 V6, 4-wheel i.s. and a full complement of luxury options like ABS, CD player and leather interior. And it's under \$20,000. Styling may be too safe, but it is one smart sedan.

FM



Mazda 929: Luxury plus superb suspension, steering and brakes.

Do you know where your next fender is coming from?

America's body shops are being flooded with imitation parts. Look-alike doors. Copycat hoods. Imitation bumpers, grilles, fenders and more. And, like many imitations, they don't come close to the originals.

These not-so-exact replicas seldom measure up to General Motors original specifications for fit, finish and corrosion protection the way genuine GM parts do.

So how do you protect yourself—and your General Motors car—from inferior imitations? Ask to see your repair order before insurance work begins. And insist on genuine GM parts. Because even though your insurance company may be paying the bill, it's still your car. And it's still your choice.



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FREEWHEELING

Corvette Mecca

ONCE every year there is a Corvette happening that is second to none. It brings together in one place, at one time, some of the most spectacular examples of a most spectacular marque. It attracts enthusiasts—thousands of them—for a 4-day celebration of the Corvette. A sensual wonderland, it is Corvette mania at its zenith. It is Bloomington.

What is it about this event that draws so many Corvette enthusiasts on the last weekend of June each year to the McLean County Fairgrounds in the little town of Bloomington, Illinois, much like Mecca attracts pilgrims? It obviously is more than a mere car show. It is, in effect, a microcosm of the Corvette hobby in its totality.

Take even the parking lot, for instance. Seas of Corvettes, some rare, some concours quality, packed together in a giant time



A sea of Corvettes wherever you look. That's Bloomington in June.

of the Corvette parts marketplace. If you can't find the Corvette parts you need at Bloomington, they probably don't exist.

Next stop is the show and sell area. About a third of those at Bloomington are there to buy, sell or trade a Corvette. Here you can see rare, limited-production and high-performance Corvettes that are jammed fender to fender with their more ordinary, daily-driver cousins. The atmosphere

here is relaxed. You can stroll around, look over the offerings and leisurely chat

with the owners who are usually sitting near their cars and maybe even barbecuing up some ribs or burgers on the grill.

The mood is considerably more feverish at the Bloomington Corvette auction. Cars that sell under the gavel act as a barometer of the Corvette marketplace itself, setting price values for these fiberglass wonders for months to come. Not every car sells. By design. Some owners pay the \$150 consignment fee and send their car through with an artificially high reserve just to see how high the bidders will go. Still, there are bargains to be had, although few and far between. And where else can you pick up a 1978 Pace Car

edition with a total of 6 miles on the odometer?

The heart of Bloomington is the Bloomington Gold Certification program. This is what started the event in the first place. Cars up for certification do not compete against each other. Rather, they are swarmed over by an army of judges who rate them on authenticity and condition. A car that's deemed to be within 95 percent of factory originality and condition receives the coveted Gold Certificate.

If Gold Certification is the heart of the event, then the Special Collection is the soul of Bloomington. Here, gathered in a museum-like setting in the Bone Student Center at Illinois State University, are 30-plus examples of the rarest, most remarkable Corvettes ever produced that relate to that year's theme. This year, the theme was "100% Fuel Injected."

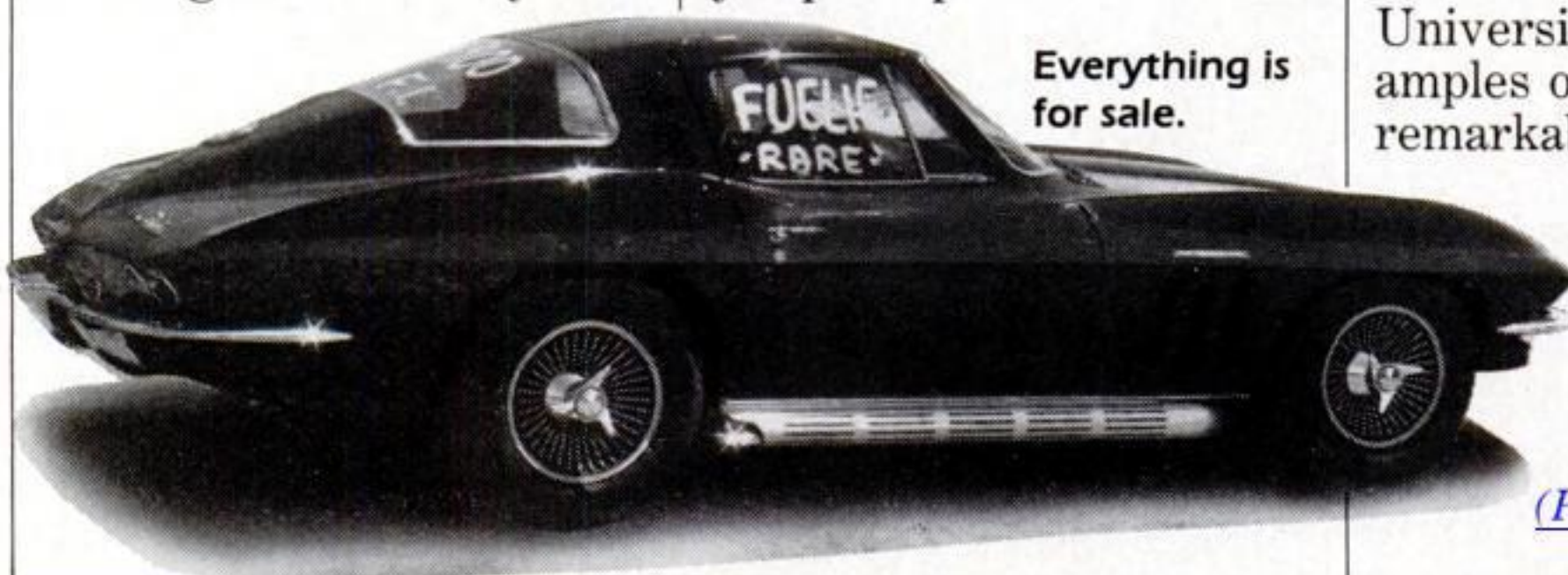
(Please turn to page 17)



Auction is a price barometer.

capsule of Corvette evolution. You can study wheel-styling development or the various fender and hood emblems that were tacked on over the years. And you're not even at the show area yet.

The first area of official activity you hit is the swap meet. Located on the outer fringe of the event, the swap meet is the barometer



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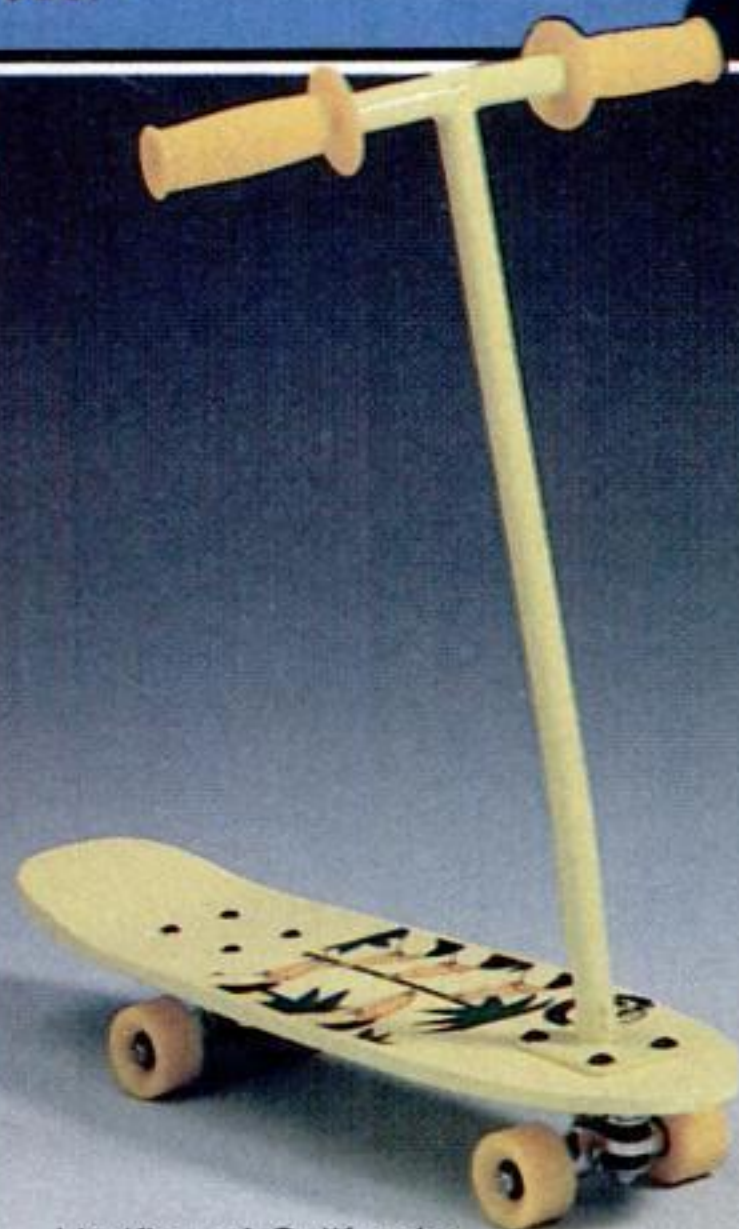
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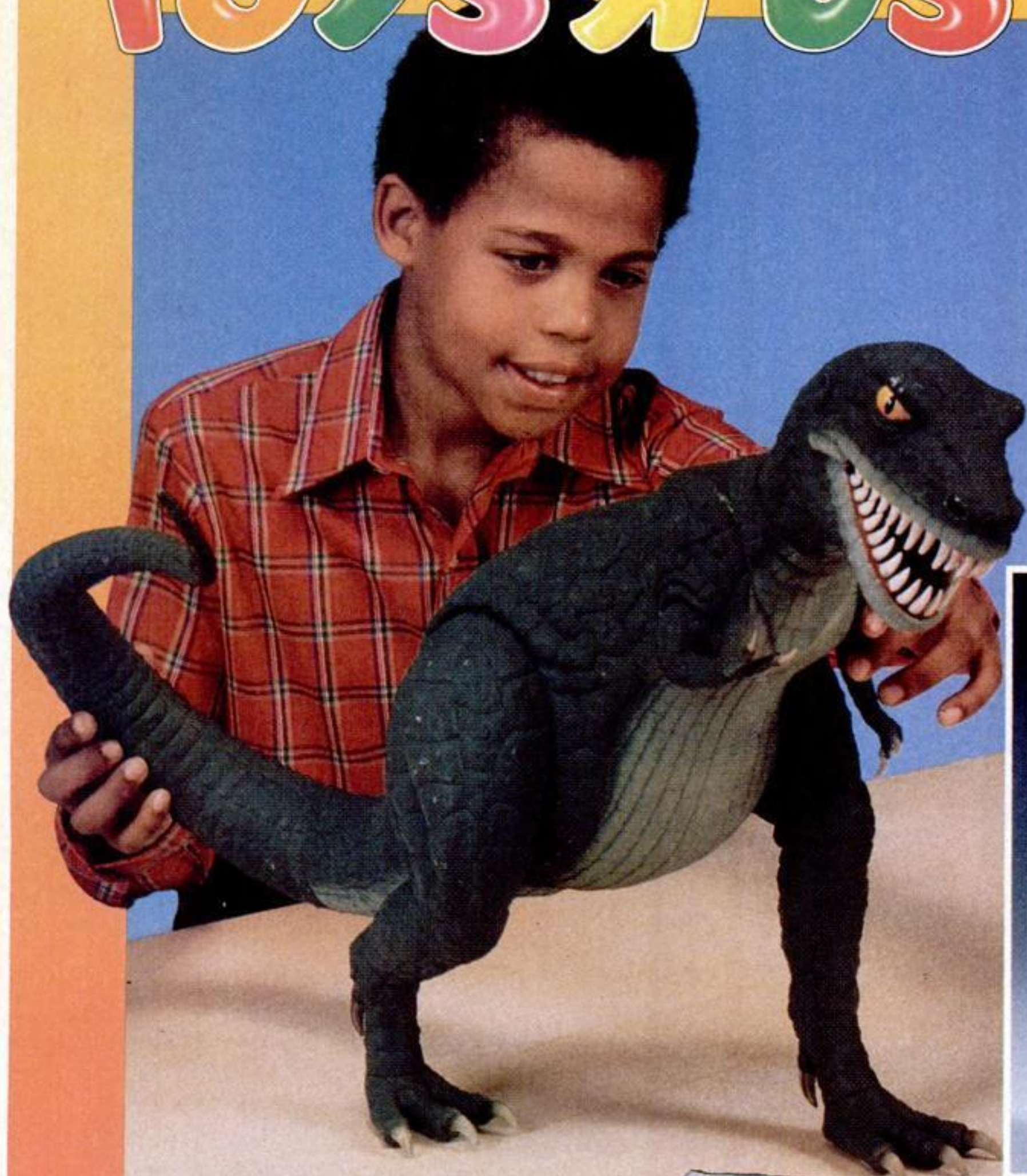
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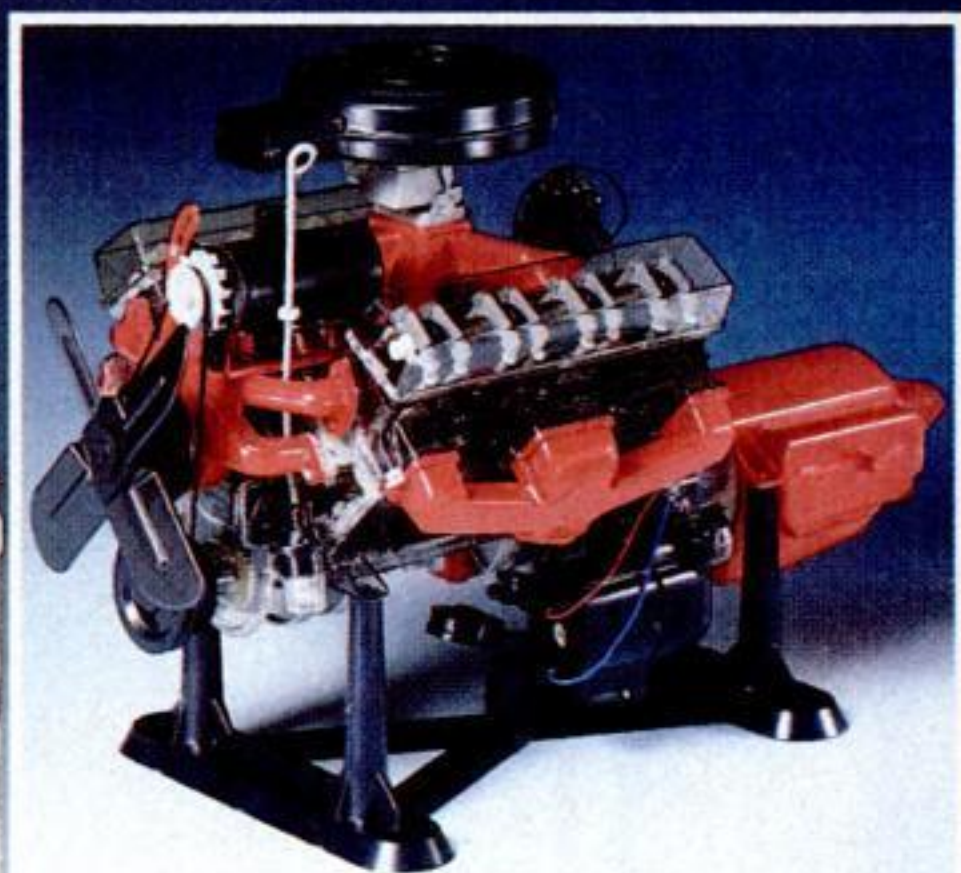


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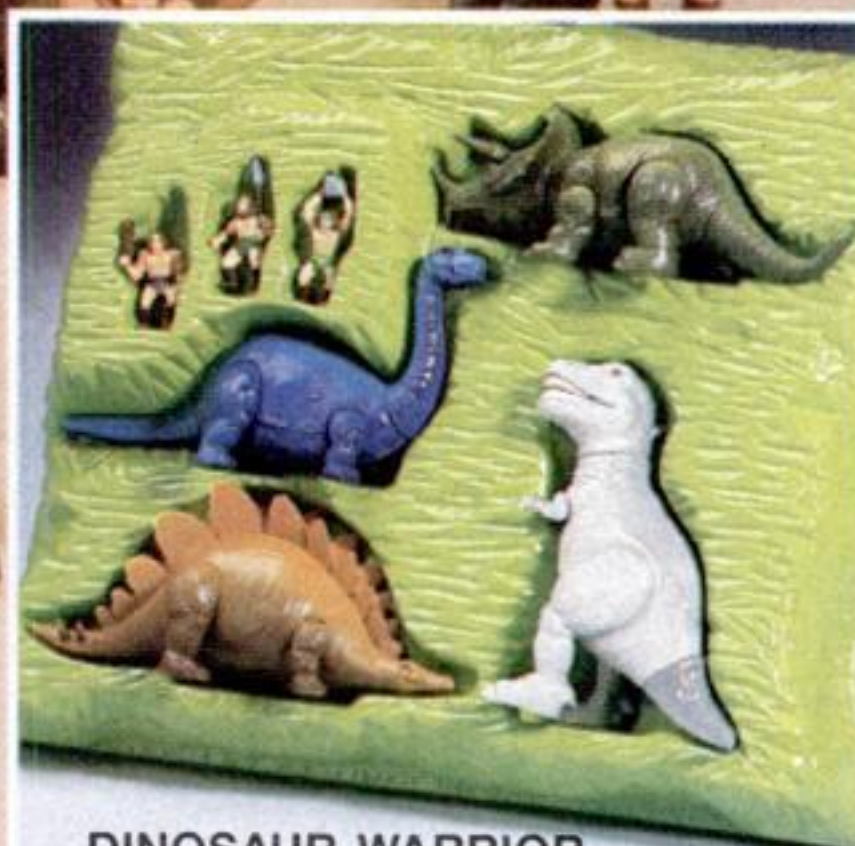
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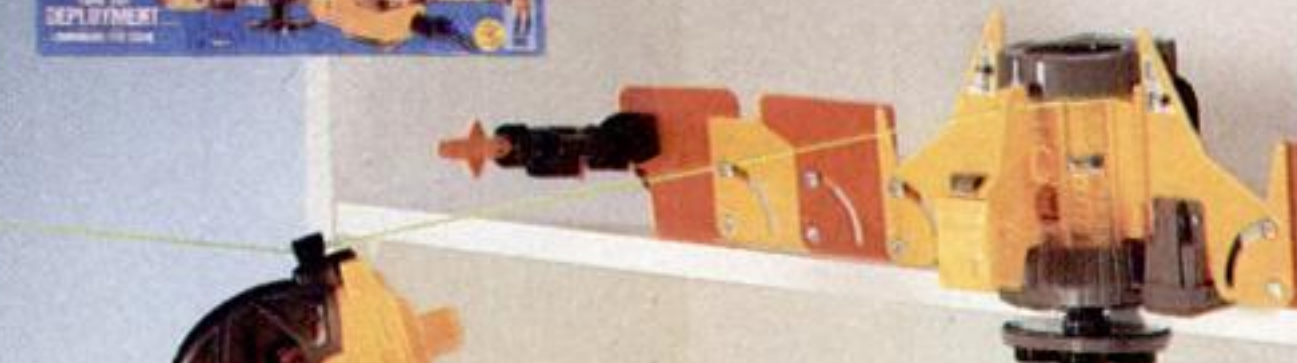
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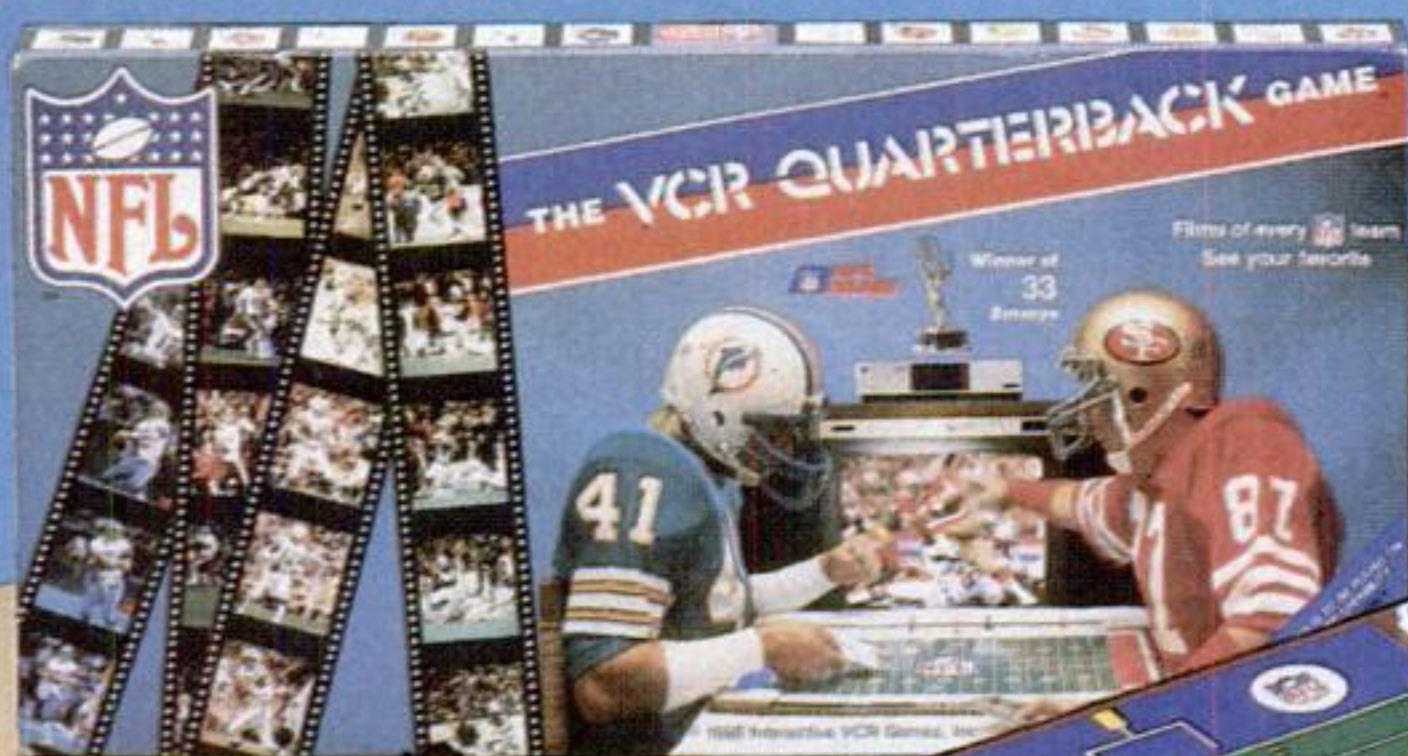
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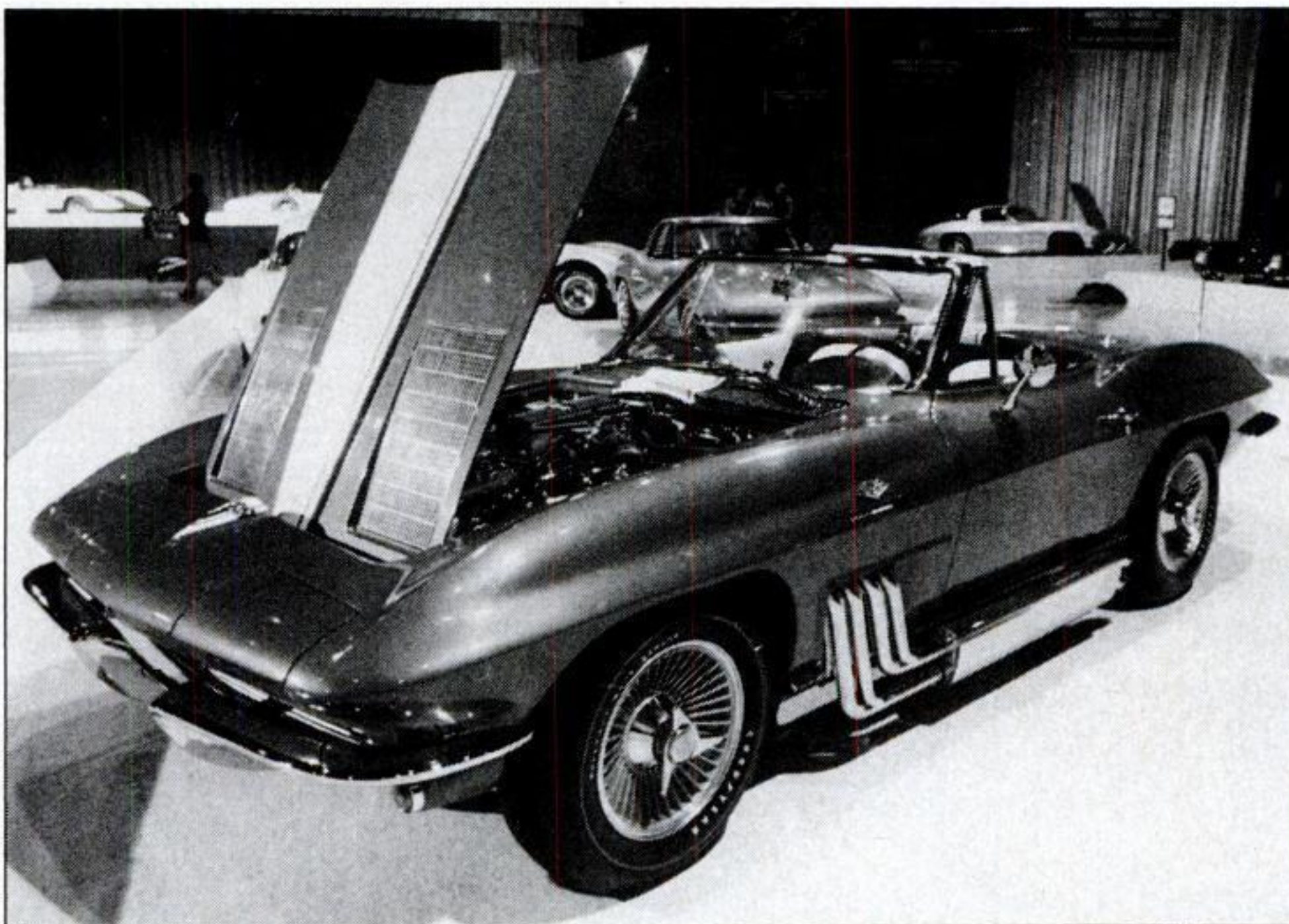


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FREEWHEELING

(Continued from page 16)



Special Collection attracts the rare and experimental to Corvette Mecca.

Next year, it'll be "L-88 in '88." Some are one-of-a-kind factory competition models. All are heavily steeped in Corvette lore and legend. This is hallowed ground for the Corvette aficionado as the cars create a unique aura and presence that is physical in its intensity.

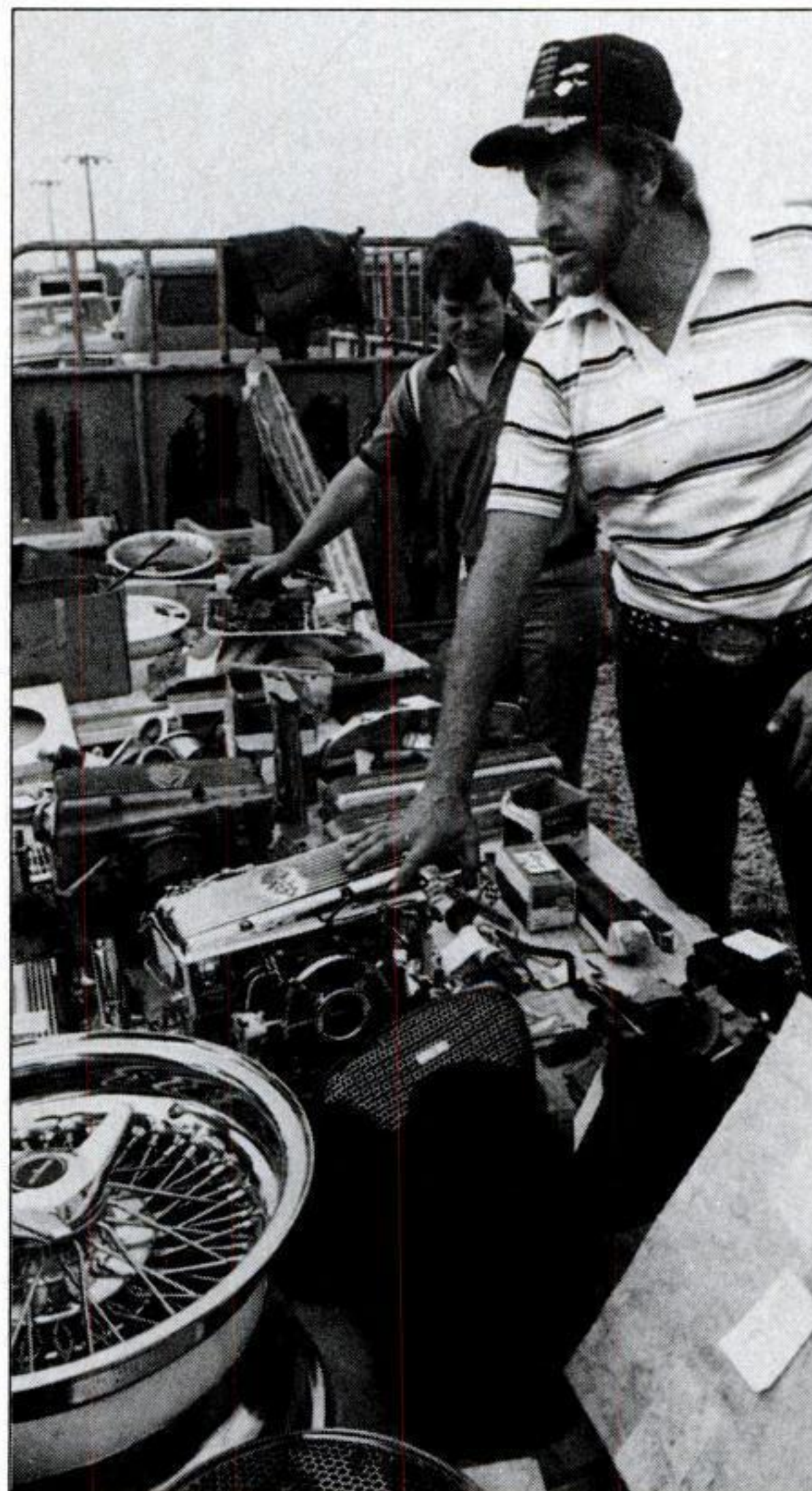
Now that you're totally sated with the Corvette experience, is it time to go home? Not a chance. It's time to overload. The folks who put on the Bloomington extravaganza pack in more events than your kid's summer camp. First, there's the road tour. Picture hundreds of Corvettes gathered nose to tail in a local shopping center parking lot. It is dusk. The setting sun casts a golden glow on the deep, glistening paint. Corvettes stretch out row upon row, filling the entire parking lot.

Then, on a signal, and led by Bloomington police cars, they pull out single file—a convoy more than 3 miles long of more than 400 Corvettes. Everything from stock and restored machines to wild customs. If it has a Corvette nameplate on it, it is there.

While the machines create their own magic at Bloomington, what really makes the event is the people. A grand gathering of

Corvette enthusiasts of all persuasions share a common bond of enthusiasm for one glorious weekend in the heartland of America.

—Cliff Gromer



"You can get any part for any Corvette."

STATEMENT OF OWNERSHIP

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION (Required by 39 U.S.C. 3685). 1A. Title of publication: Popular Mechanics. 1B. Publication No.: 00324558. 2. Date of filing: Oct. 1, 1987. 3. Frequency of issue: Monthly. 3A. No. of issues published annually: 12. 3B. Annual subscription price: \$13.97. 4. Complete mailing address of known office of publication: 224 West 57th Street, New York, New York 10019. 5. Complete mailing address of the headquarters of general business offices of the publisher: 959 Eighth Avenue, New York, New York 10019. 6. Full names and complete mailing address of publisher, editor, and managing editor: Publisher: The Hearst Corporation, 959 Eighth Avenue, New York, New York 10019. Editor: Joe Oldham, 224 West 57th Street, New York, New York 10019. Publisher: Daniel J. Coleman, 224 West 57th Street, New York, New York 10019. 7. Owner: The Hearst Corporation, principal office, 1209 Orange Street, Wilmington, Delaware 19801-Stockholders owning or holding 1 percent or more of total amount of stock of The Hearst Corporation are: Trustees of Trust created under the Will of William Randolph Hearst, Deceased, namely: Frank A. Bennack, Jr., Millicent Hearst Boudjadjji, Richard E. Deems, George R. Hearst, Jr., John R. Hearst, Jr., Randolph A. Hearst, William R. Hearst, Jr., Harvey L. Lipton, Frank Massi, Gilbert C. Maurer, Raymond J. Petersen, J. Kingsbury-Smith, Franklin C. Snyder, the address for all the foregoing being 959 Eighth Avenue, New York, New York 10019. Those having a beneficial interest in the Trust mentioned above are: William Randolph Hearst, Jr., Phoebe Hearst Cooke, George R. Hearst, Jr., Randolph Apperson Hearst, David Whitmire Hearst, Jr., Millicent Hearst Boudjadjji, John Randolph Hearst, Jr., William Randolph Hearst, II, Joanne Hearst Lawrence and Deborah Hearst. 8. None. 9. For completion by nonprofit organizations authorized to mail at special rates (Section 423.12 DMM only) The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes (Check one) ☐ Has not changed during preceding 12 months. ☐ Has changed during preceding 12 months. (If changed, publisher must submit explanation of change with this statement.) 10. Extent and nature of circulation. A. Total no. copies (net press run): Average no. copies each issue during preceding 12 months, 2,004,384; actual no. copies of single issue published nearest to filing date, 2,008,800. B. Paid and/or requested circulation: 1. Sales through dealers and carriers, street vendors and counter sales: Average no. copies each issue during preceding 12 months, 273,215; actual no. copies of single issue published nearest to filing date, 261,000. 2. Mail subscription (paid and/or requested): Average no. copies each issue during preceding 12 months, 1,369,590; actual no. copies of single issue published nearest to filing date, 1,374,000. C. Total paid and/or requested circulation (Sum of 10B1 and 10B2): Average no. copies each issue during preceding 12 months, 1,642,805; actual no. copies of single issue published nearest to filing date, 1,635,000. D. Free distribution by mail, carrier or other means samples, complimentary, and other free copies: Average no. copies each issue during preceding 12 months, 22,479; actual no. copies of single issue published nearest to filing date, 23,200. E. Total Distribution (Sum of C and D): Average no. copies each issue during preceding 12 months, 1,665,284; actual no. copies of single issue published nearest to filing date, 1,658,200. F. Copies not distributed: 1. Office use, left over, unaccounted, spoiled after printing: Average no. copies each issue during preceding 12 months, 9,815; actual no. copies of single issue published nearest to filing date 11,600. 2. Return from News Agents: Average no. copies each issue during preceding 12 months, 329,285; actual no. copies of single issue published nearest to filing date 339,000. G. Total (Sum of E, F1 and 2-should equal net press run shown in A): Average no. copies each issue during preceding 12 months, 2,004,384; actual no. copies of single issue published nearest to filing date, 2,008,800. 11. I certify that the statements made by me above are correct and complete. Signature and title of Publisher: Daniel J. Coleman.

STATEMENT OF OWNERSHIP

How they stand up to each other

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Chevy has a Getrag-licensed 5-speed manual transmission with overdrive. Ford doesn't.

Chevy has a new double A-arm independent front suspension. Ford doesn't.

Chevy has more glass area than Ford—933 more square inches of glass.

Chevy's big new cab gives you more leg room, more shoulder room and more total room than Ford.

Chevy has two-side-galvanized steel front, sides and rear—more of it than Ford.

Chevy gives you shift-on-the-fly Insta-Trac as standard equipment on all 4x4s. Ford still makes you stop, get out and change hubs.

Chevy protects the paint with a new clear-coat finish you can't get from Ford.

Chevy half-ton gives you a strong, massive new frame that's bigger and heavier than Ford's.

Chevy has a new all-welded cargo box with no exposed bolt heads to trap water and cause rust. Ford doesn't.

Chevy has special indentations in the cargo box that let you build a platform of 2x6s across the top of the wheelhousings for two-tier loading. Ford doesn't.

Feel the news behind the wheel. Test drive the first all-new full-size pickup introduced in this decade.* At your Chevy dealer's.

*Excludes other GM products.

Comparisons based on data available at time of publishing.

Let's get it together... buckle up



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Best-backed Chevys ever. 6-year/60,000-mile powertrain warranty protection and 6 years or 100,000 miles of outer-body rust-through protection. Solid proof of the quality built into every new 1988 full-size Chevy pickup.

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TODAY'S CHEVY TRUCK





OLD NEW FORD.

Ford says they're new. But you'll find their 1988 pickup doesn't have much new to talk about: taillight lens, revised fuel-tank capacities, tethered fuel-filler cap and integral alternator/generator.

OLD HOUSE RESTORATION

BY BOB VILA

The Return Of The Tin Ceiling

THERE'S an old saying "what goes 'round, comes 'round." You know if you keep something long enough it's bound to come back into style. Fortunately for old-home restorers and for new-home owners alike, the pressed-tin ceiling is one product that has "come 'round" again.

I think the comeback of the tin ceiling can be partly attributed to the increased interest in restoration we've seen over the past 10 years. I also think the "nostalgia" craze, which has had an effect on both residential and commercial construction, is partly responsible. In addition, metal ceilings blend in quite well with some contemporary decorating schemes.

It's not uncommon today to see ornate ceiling treatments at your favorite pub or restaurant. But to the homeowner, the availability of these materials has opened up a whole new area for decoration and adornment overhead.

A cure for old plaster

Tin ceilings are popular today for most of the same reasons they became so at the turn of the century. They provide a relatively easy and inexpensive way to create a permanent, decorative ceiling.

Introduced in the late 1800s, metal ceilings were widely used in both commercial and residential buildings. Often seen in a home's kitchen and formal rooms, pressed-tin panels were considered a practical way to cover damaged plaster. The fact that the metal tiles were fire-resistant was an added bonus.

It wasn't long before

Contributing Editor Bob Vila is host of public television's "This Old House."



Pressed-tin ceiling components are available in a wide variety of different patterns and styles. The sampling shown above includes square panels, long cornice pieces and various moldings.



Components can be attached directly to wood ceilings or to furring nailed over a plaster or drywall. The arrangement shown consists of 2x8 panels surrounded by a cornice and crown molding.

folks realized tin panels allowed them to install what looked like an expensive hand-carved plaster ceiling relatively easily—even on a new surface.

Obviously, the ornate plasterwork the metal tiles imitated couldn't be mass-produced and shipped like a pressed-tin ceiling could. And, of course, the price for hand-detailed plasterwork then, as now, was exorbitant.

Made vigorously into the '30s, the industry slowed with the coming of World War II. It lay dormant for decades, until its re-emergence in the late '70s.

Yesterday's ceilings today

Two leading manufacturers of metal ceilings are the W.F. Norman Corp. and the Shanker Steel Ceiling Co., Inc. Interestingly enough, both companies use the same machines and dies to make today's ceilings that were used almost a century ago. (You can't get much more authentic than this!)

Most tin ceilings are easy to install and are generally put up by do-it-yourselfers with a great deal of success. One caution, though: The edges are sharp, so be sure to wear work gloves to protect your hands when handling the panels.

Generally available in 2 x 4-ft. and 2 x 8-ft. panels, metal tiles are usually nailed to either solid wood, wood furring or wood sheathing. A metal ceiling is installed in much the same way as a tile floor—the main difference is you're working above your head! If you want a mechanically perfect job, the pattern should be centered, then worked out to the edges. Many times, a generic filler is used between the end of the pat-

tern and the surrounding walls. Adding a cornice or molding along the edges completes the look.

Some metal tiles are also available in 2 × 2-ft. squares for installation in drop-in acoustical ceiling grids. These tiles can also be screwed to metal furring strips, if the job calls for it. It has been my experience, though, that these last two items are usually reserved for commercial installations, where it's necessary to have access to the mechanical systems located above the ceiling panels.

Expect to pay about \$2 a sq. ft. for most pressed-tin panels used in homes. Some of the bolder patterns, which have more profile and are deeply coffered, are usually priced a bit higher—\$2.50 to \$2.75 a sq. ft. is a good range for these. Normally, you wouldn't cover an entire ceiling in your home with this bolder stuff. It is popular, though, to use a more subtle pattern in the room in general and maybe add a bolder panel—like a medallion above a chandelier or ceiling fan—in the center.

Traditionally, most metal ceilings were painted. The same holds true today. Any high-quality, oil-based paint will do. But do not use latex paint on metal panels—the water in it will cause rust.

It's becoming more and more popular, especially in contemporary installation, to leave the tin unpainted. If you desire a shiny metal look, the surface must be preserved with two coats of polyurethane. Make sure each tile is free of dirt and oil before this finish is applied.

Plastic panels

There are also plastic panels available today that replicate pressed-metal ceilings. The company I'm familiar with that makes these tiles, The Old Jefferson Tile Co., manufactures exact replicas of the old tin ceilings out of high-impact polymer styrene plastic in squares about 2 × 2 ft. Generally priced a bit lower than the authentic metal version, you can expect to pay between \$1.55 to \$1.65 per sq. ft., depending on the amount of tile you order.

Although most plastic tiles are commonly installed in acoustic ceiling grids, some can be applied directly to any reasonably sound ceiling surface, including plaster, plasterboard or plywood. Most standard adhesives (as long as they don't caution against use with plastic) will work.

You can also staple the plastic squares to the ceiling surface, then glue a thin overlay strip molding over the seams. In the same way, rosette

(Please turn to page 23)

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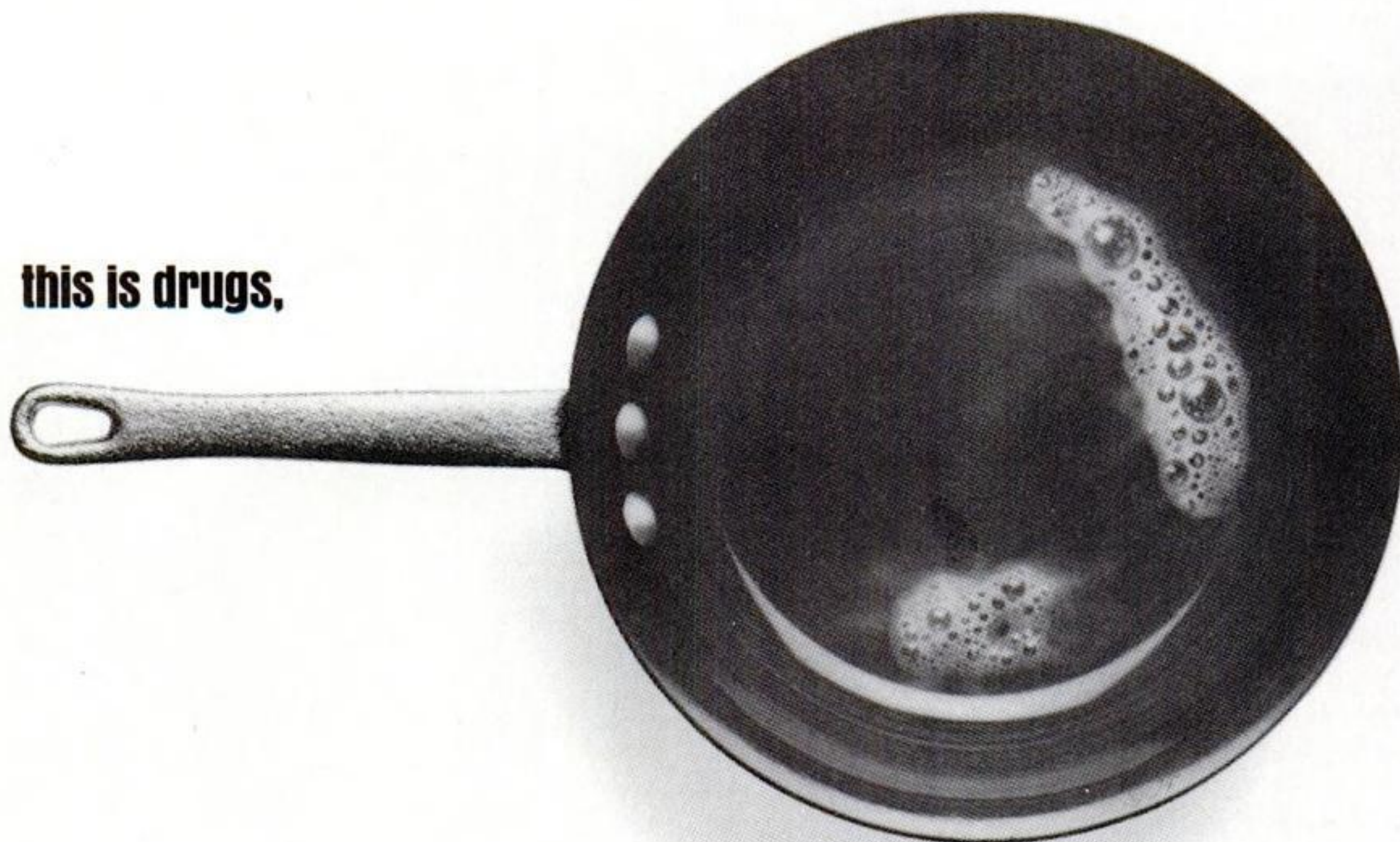
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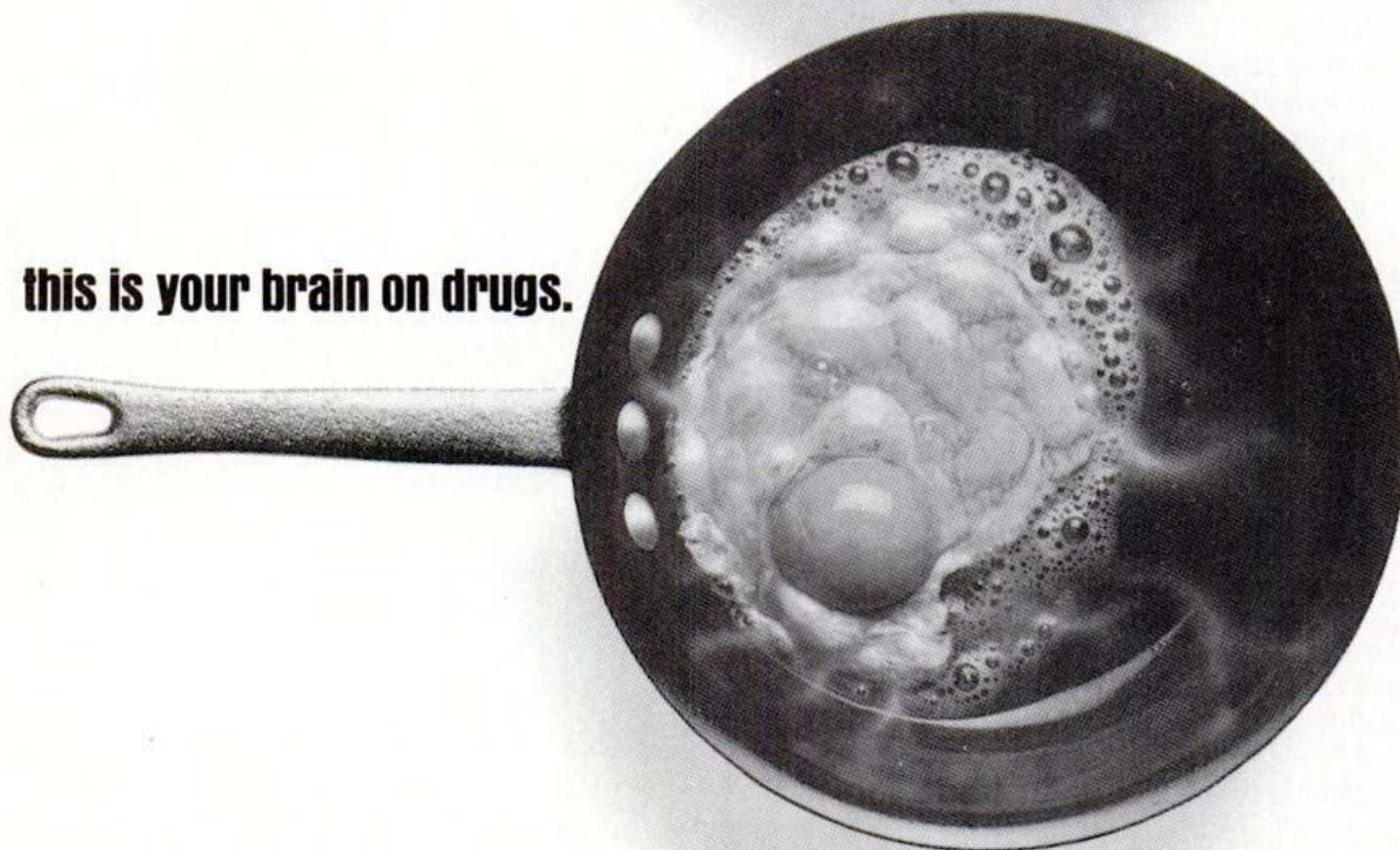
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OLD HOUSE RESTORATION

(Continued from page 21)

medallions cover each corner junction. (In a ceiling grid installation, the moldings and medallions can be used to conceal the metal strips.)

One of the advantages to this type of ceiling is that the tile can be scored and cut easily. Obviously, the nature of the material has eliminated the danger from cuts sharp metal edges may cause.

Restoring with tin

For those involved in renovation and restoration work, the pressed-tin ceiling is an ideal way to cover a damaged plaster ceiling, while creating the look of old, decorative carvings. Even if you could find plasters capable of doing this type of work today, chances are you wouldn't be able to afford them. So, like the work of yesteryear, metal ceilings fill a similar need today.

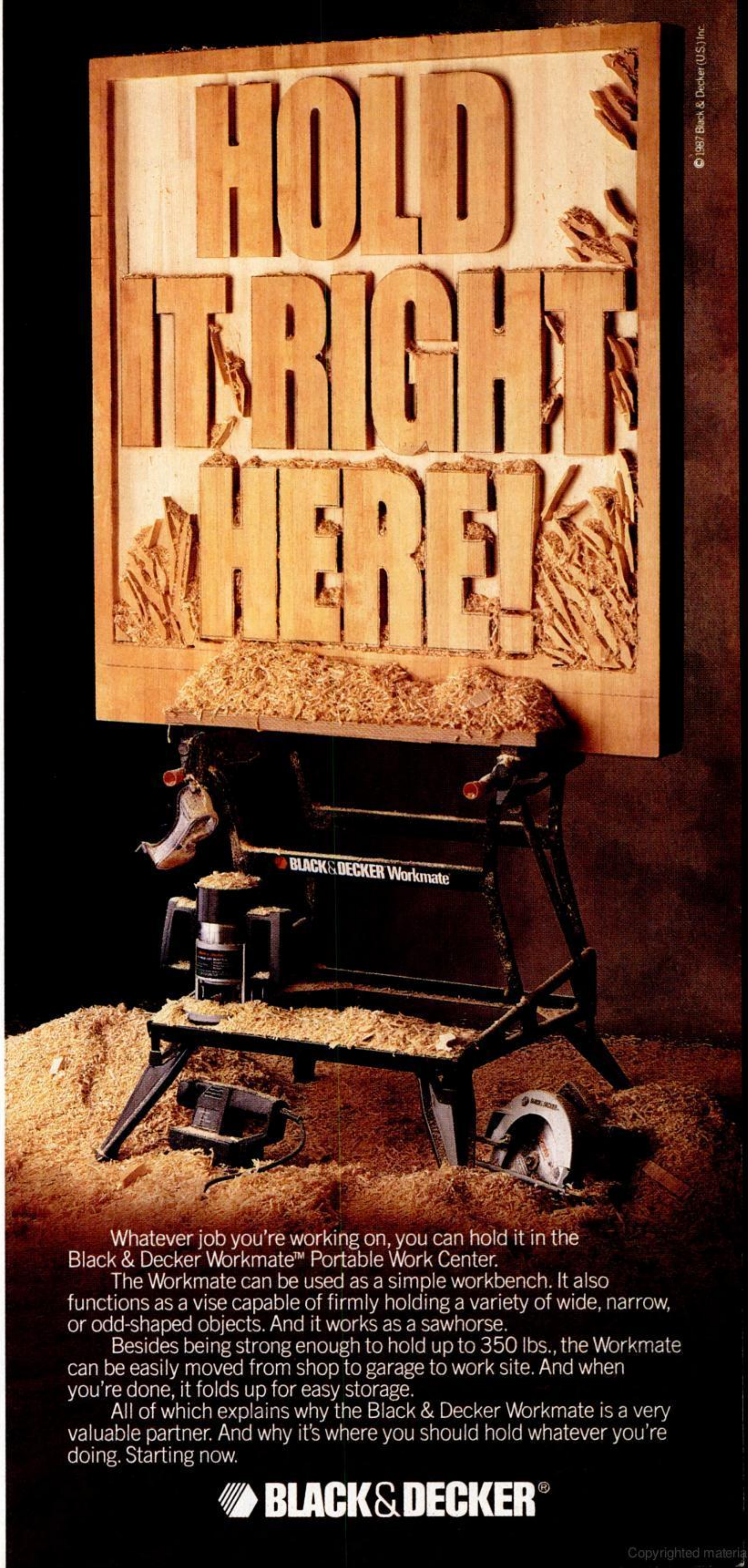
Perhaps you've already got an old tin ceiling in your home you'd like to keep, but a few of the edge tiles have rusted from water leakage—the main culprit in metal-ceiling damage. First, check through the manufacturers' catalogs for the patterns available today. There's a chance that what was originally put up in your home may still be produced. If that's the case, just order the few replacement tiles you need. If the damaged tiles are bubbly and sagging, pull them out before replacing with the new ones. But if they are laying flat, you can sometimes get away with putting the new tiles right over the old.

Because of the reasonable \$2 per sq. ft. cost of tin tiles, it doesn't pay to try to salvage what's there. But if only a few tiles on the ceiling's perimeter are water damaged, you can sometimes replace them with tiles from the center that are still in good condition. Then choose a new bold panel—perhaps one with a medallion—to replace the center panels you've moved. If it's done right, this little trick can make an old tin ceiling look super!

So, adding decorative tiles may be just what that damaged plaster ceiling in your old house needs. Or it can help bring a bit of "nostalgia" into your newer home. In any case, I think you'll agree that it's nice to see these ceilings have "come 'round" again. **PM**

SOURCE LIST

- Shanker Steel Ceiling Co., Inc., P.O. Box 4396, Linden, NJ 07036
- W. F. Norman Corp., Box 323, Nevada, MO 64772, (catalog, \$3)
- The Old Jefferson Tile Co., P.O. Box 494, Jefferson, TX 75657



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OUTDOORS

BY JOE SKORUPA

Big Event, Small Fish



Contenders jockey for position just after sunrise at the '87 Bass Masters Classic and prepare to roar off in search of elusive fish.

DAYBREAK at Cox's Landing, 10 miles northeast of Louisville, Kentucky, on the Ohio River. Most days a fisherman would be alone with his thoughts here at 6 a.m.

Not today.

Today is the 17th running of the Bass Masters Classic, "test of the best," as the organizers like to call it. The shores are lined with 6500 spectators listening to amplified country music and a folksy emcee.

A caravan of Ranger Bass Boats arrives—41 state-of-the-art rigs pulled by a fleet of new Chevy vans and trucks. Inside the rigs are the reason the crowd is here—the top 41 finishers on the Bass Anglers Sportsman Society (BASS) tournament trail.

"I'm going to work late today," one pre-dawn spectator tells me at the boat ramp. "These are the guys

we see on TV and in the magazines."

The bass boats are launched and line up in the center of the river. At the sound of the gun they rear up like stallions, 150-hp Johnson GT outboards digging in for a solid bite of the Ohio, and then, with prop wakes stretching out in ever-expanding parallel lines, the all-star fishermen roar off in search of elusive fish. First place at the Classic brings the winner a purse of \$50,000 and the opportunity to reign as champion for a year, a career boost worth much more than the prize money.

Unlike other tournaments, few spectators actually see any action. The focal point isn't the sport, but the show at the weigh-in, where standings are updated and contenders tell fish stories. It's emceed by garrulous Ray "Mr. Bass" Scott, founder of BASS and originator of the event.

On the final day of competition, approximately 18,000 fans crowded into Freedom Hall, at the Kentucky State Fairgrounds, to cheer the crowning of George Cochran as '87 champ. To his credit, Cochran caught 14 fish in three days, weighing 15 pounds, 5 ounces.

Most knowledgeable fans knew that Cochran's small winning stringer—smallest

in Classic history—was a major fishing feat.

Despite lack of shoreline development, this stretch of the Ohio is a fully exploited commercial waterway with few feeder creeks or other natural fish-producing features.

More than a third of the contenders arrived at the weigh-in each day without fish. Thirteen caught a total of three or less, and two, proving they're human, struck out completely.

Since few fans were actually out on the water, they didn't know that one pro's state-of-the-art bass boat died on him and that one was fined for fishing in a restricted area. They didn't know that one pro was run

off a creek by a shotgun-toting Hoosier and one ran 50 yards of line through his trolling prop.

Few also knew that the fish stories told by pros to the crowd and media were, well, fish stories. One of the top finishers told the crowd he ran 100 miles or more each day to catch fish. The next day, we spotted him fishing near the boat launch. "I'm going to stick within 10 miles," he said. "I didn't really mean that stuff I said for the press."

Everything about the '87 tournament indicated that the Bass Masters Classic is getting bigger in every way. The only thing that got smaller was the size and quantity of fish.

GMC Pan Am Challenger Put to Test



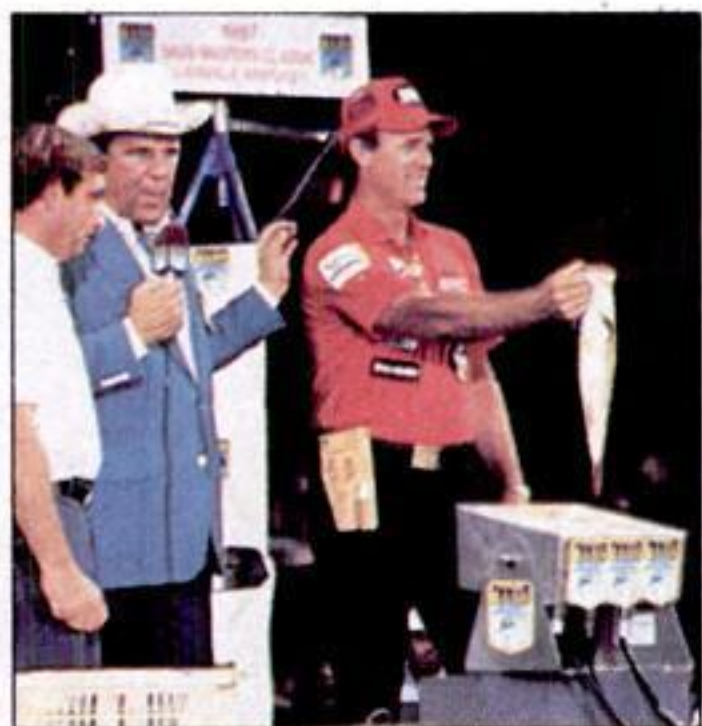
PM wrings out Sowerby's record challenging GMC Sierra pickup.

The lure of long-distance driving is universal, but no one does it like Canadian Garry Sowerby, of Moncton, New Brunswick. If all goes according to plan, Sowerby will set a world record in late '87 by driving from the tip of Tierra del Fuego to Prudhoe Bay, Alaska, the northern and southern most driveable points in the Americas.

The *Guinness Book Of World Records* considers this the world's longest drive. Sowerby and co-driver, Tim Cahill, an experienced adventurer, plan to complete the 15,000-mile trip in about 25 days and go into the record books.

To accomplish the feat, Sowerby has chosen a 1988 GMC Sierra Club Coupe pickup, which has an extended wheelbase of 155.5 in. and a rear passenger seat. The Sierra is GM's first totally re-engineered full-size pickup since 1972. Sowerby's is outfitted with 4-wheel drive and a 6.2-liter diesel. Though the new production-line Sierra is built to

(Please turn to page 28)



Guy Eaker holds up a rare sight at the '87 Classic—a 4-pounder.



Its competition is

Dodge Raider. Standard to standard, the best equipped import 4x4 on or off the road.

If you've been looking for a 4x4 that really stands out, meet the 1988 Dodge Raider. The import so well-equipped, it elevates off-roading to a fine art. While blowing its Japanese competition straight into the weeds.* And right out of the scene.

Features Toyota won't give you. Raider is armed to the teeth with some features you won't find standard on Toyota 4-Runner. Like automatic locking hubs. Both front and rear tow hooks. A full set of



Dodge Raider — \$11,083†



out of the picture.

easy-to-read gauges including an inclinometer. And hot-looking spoke wheels.

Comfort Nissan considers optional. Raider is at home on the range. But it also has a standard comfort level that leaves Nissan Pathfinder in its dust. With cloth and vinyl bucket seats. Full carpeting. An adjustable steering column. And there's an available driver's seat with its own bump-smoothing suspension.

A price they can't match. Even with all of this standard, Raider still has a low base list price of only \$11,083. Hundreds less than competitors such as Nissan Pathfinder and Toyota 4-Runner.

Making our Raider one of the best sport utility values on the road. Or off.

The 1988 Dodge Raider. When you're ready for the one import 4x4 that likes to give a lot more than it takes, just see your Dodge dealer. Then put yourself in the picture. Front and center. And all alone.

*All comparisons are to 1987 competitive models (1988 competitive data incomplete at time of printing).

†Base list price at time of printing, excluding tax & destination charge.



Dodge Import Trucks. We're going places.

BUCKLE UP FOR SAFETY.

DIVISION OF CHRYSLER MOTORS

OUTDOORS

(Continued from page 25)

take a pounding, Sowerby made a number of design modifications to prepare for terrain ranging from jungle to high mountain passes.

The cap over the pickup box gives the vehicle enclosed space for storage and sleeping accommodations. Other modifications include: 100-gallon fuel cell, double shocks in rear axle, front brush guard, Hayden oil cooler and many others.

Sowerby picked up the customized Sierra a few weeks before shipment to

South America to wring out any bugs and asked POPULAR MECHANICS to give it a test drive. We took it south of Moncton to the rugged Bay of Fundy, source of the world's highest tidal activity, and drove over packed-sand and loose-rock beaches. We also took it through mountain roads and did power slides and spin outs in gravel.

The Sierra was surefooted in all situations. Thanks to its gutsy 6.2-liter diesel, the loaded-down 1-ton accelerated with ease and cruised effortlessly in the 75 to 80 mph range. (Sowerby intends to go beyond the U.S. speed limit for much of the trip.) Steering

was tight and responsive, and the suspension flattened the bumps.

Sowerby is no stranger to long-distance driving. He has a number of major road trips to his credit, two of which are recognized world records. By the time you read this, a new record will be among his, and his customized Sierra's, accomplishments. (Look for exclusive PM coverage of Sowerby's Pan American Challenge in the February 1988 issue.)

Tough Truck Topper

Brahma wanted to prove it made a tough topper/shell for 4x4 pickup trucks, so it did the only logical thing. Brahma turned the project over to Joie Chitwood Jr., renowned thrill-show stunt driver, who decided to give it a roll. Literally.

Chitwood drove up a ramp at 30 mph and flipped a Brahma-topped Chevy truck wheel-to-wheel. The truck suffered a crunched hood, windshield and front end. The Brahma Topper, made of Dow Chemicals' Roval composite plastic, compressed under the impact, getting a few paint scratches, and returned back to its normal shape. The truck still ran, so Chitwood rolled it again. The result was the same. Chitwood doesn't recommend simulating this test, but believes, in case of an accident, the topper will cushion a roll and absorb some of the shock. In addition, it will still be in good shape. Brahma is based in Grand Prairie, Texas.

Wild New Arctic Cat

Muscle snowmobiling just got pumped up another notch with the introduction of Arctic Cat's new Wildcat, powered by a big 650 cc Suzuki engine. This liquid-cooled, twin-cylinder powerplant, which breathes fire through twin 38-mm carbs and high-performance exhaust chambers, is built for one thing—speed.

Along with a huge engine, the Wildcat features 7½ in. of progressive travel suspension, in the rear, and 7 in. at the skis, in front, which not only give comfort to the ride, but more control over bumpy terrain. Twist this sled's throttle and hang on. Arctic Cat is based in Thief River Falls, Minnesota. Cost is \$5695. **PM**



Huge engine and advanced suspension make new Wildcat a high-speed muscle sled.



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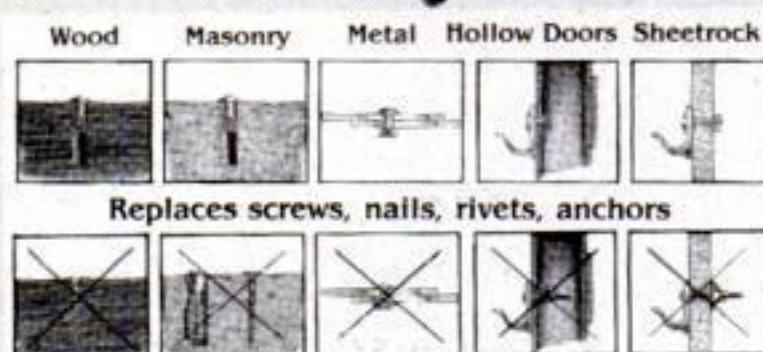
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INSIDE DETROIT

BY JIM DUNNE

King Corvette

KING of the Hill Corvette is the popular name for this monster that Chevy's developing for 1989. And by the time it hits the showrooms, it may be indeed the king among performance street machines. Under the hood is an awesome 400 hp/400 lbs.-ft. of torque from a specially altered 350-cu.-in. V8. Lotus modified the engine with special heads and double overhead cams. The transmission is a 6-speed manual imported from Europe. To handle all that power, King Corvettes have larger tires—17 in. dia. with a tread width that is 1½ in. wider than the 9 in. on today's Corvette. Rear fenders had to be widened by 3 in. to fit them. The wider



King of the Hill Corvette, due in '89, will pack a 400-hp wallop.

headlights, has been altered slightly to give the car a lighter look in front. Functional details include Mazda's 1.6-liter ohc Four that drives the front wheels. A manual or automatic transmission will be offered. Ford expects to sell this vehicle at the lower end of the price spectrum and shoppers can look for a fairly well-equipped version to be in the sub-\$10,000 range. Why did Mercury get the Capri instead of Ford dealers? The factory is limited in production, so the Capri could not be spread out in sufficient numbers for all Ford dealers.

Chevy Sports Coupe

It may not be called the Monte Carlo, but this is Chevy's version of the GM-10 car, a cousin to the new Grand Prix, Regal and Cutlass Supreme. It's scheduled for introduction as a 1990 model and will fit in the Chevy lineup just above the Beretta. Unlike the current Monte Carlo, the new car will have front-wheel drive and unit-body construction. Engine lineup will be headed by a 3.1-liter V6,

but a refined version of the Quad-4 will also be available. Chevy will also have a 4-door version of this car ready in 1990.

4-Door Bronco II, S-10 Blazer

Both Ford and GM are preparing an answer to the sales lead Jeep has with its 4-door Cherokee in the 4-wheel-drive utility field. Prototype 4-doors are being built now, in preparation for a 1990 model introduction. While the S-10 Blazer (and Jimmy) are reportedly just stretched versions of the current 2-door models, Ford is planning a more extensive change for the 4-door Bronco.

For one thing, the Bronco will look less like the Ranger pickup, and more like the full-size Bronco. Grilles, headlights and front bumpers will be exclusive with the Bronco II. The 4-doors will be longer, wider and have a different rear axle than the 2-door Bronco II. Wheelbase will be stretched to 111.9 in. from the current 102.1 in. and

overall length will be more than 22 in. longer at 180.9 in. Both GM and Ford will install bigger engines, in order to compete with Jeep's performance advantage. Jeep owns the 4-door utility market for smaller vehicles now. Its sales run 85 percent 4-door Cherokees, 15 percent 2-door.

Cadillac's V12 Engine

"I don't understand it either," says GM's new President Bob Stempel, commenting on persistent reports of Cadillac developing a new V12 engine. "But if that's what the customer wants, that's what we will give him."

Stempel pointed out that Cadillac had trouble putting a V8 engine in its front-drive deVille models just a few years ago. It was too long to fit sideways under the hood, so major changes were made in the accessory drives to make the package shorter. A V12 layout would obviously be even longer and pose greater problems of fit.

But competition could change Stempel's mind. With BMW putting a V12 in service this year and Mercedes' V12 in the wings, Cadillac will be forced to come up with something just as impressive. Evidently, under GM's new

(Please turn to 32)



Affordable fun from down under: 2+2 Capri.

tires at the rear and a huskier look in the rear bumper, plus rectangular taillights, tell the onlooker that this is a special model. The rear bumper also has a different look—convex instead of concave.

New Capri

Mercury dealers will be selling this 2+2 convertible within 18 months. It was called the Barchetta, a code name for a project that involved Ford in the U.S. and Australia, Mazda and the Italian design house of Ghia. Capri is the name Mercury dealers will use. The car will be built by Ford in Australia to fit a chassis design by Mazda, the same chassis that Mazda uses for its 323 sedan.

The original Ghia design, which included large, flush



With current rear-drive Monte Carlo retiring in '88, Chevy is readying this front-drive, based on GM-10 platform, for 1990.





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INSIDE DETROIT

(Continued from page 30)

policy of giving the customer what he wants, a V12 is in Cadillac's future. Look for this engine, if it ever gets into production, to be used first in the rear-drive chassis.

Shop At Home

Buick has a computer disc that allows new-car shoppers to learn about what is available on new cars, and to select a new car while operating their home or office computer. The program disc is called "Dimension." It is designed

for use in Macintosh-type computers. The discs describe high-technology systems like turbocharging, and present the type of car the operator would like to buy. Comparisons are made with Buick's competition as well as with different Buick models. Information like list price, option price and fuel economy is presented.

Chrysler's V10

Chrysler is quietly going ahead with its V10 engine program, to give the company the strong powerplant it needs for the large motorhome and specialty chassis market. The idea of

the V10 is to add two more cylinders to the current 360 V8 engine, and produce the kind of muscle that only a 400-plus-cu.-in. size will produce.

Chrysler can move to a V10 at low cost by adapting the engine line that now makes V8s to the V10 layout. Look for this engine in 1991.

Opel Invasion

General Motors is poised to bring Opel back to the U.S. market, probably for the 1989 model year. Although details are yet to be worked out, Opel will likely be operated as a separate franchise with three different models offered initially—the top-of-the-line Senator, the new Omega and, probably, the Ascona. The Ascona will be all-new in the fall of 1988, and is expected to be available with 4-wheel drive later in the '89 year.

With prices expected to range from near \$20,000 to upward of \$30,000, it's clear that GM's aim is to attract buyers who already drive German luxury cars, as well as those considering expensive Japanese sedans.

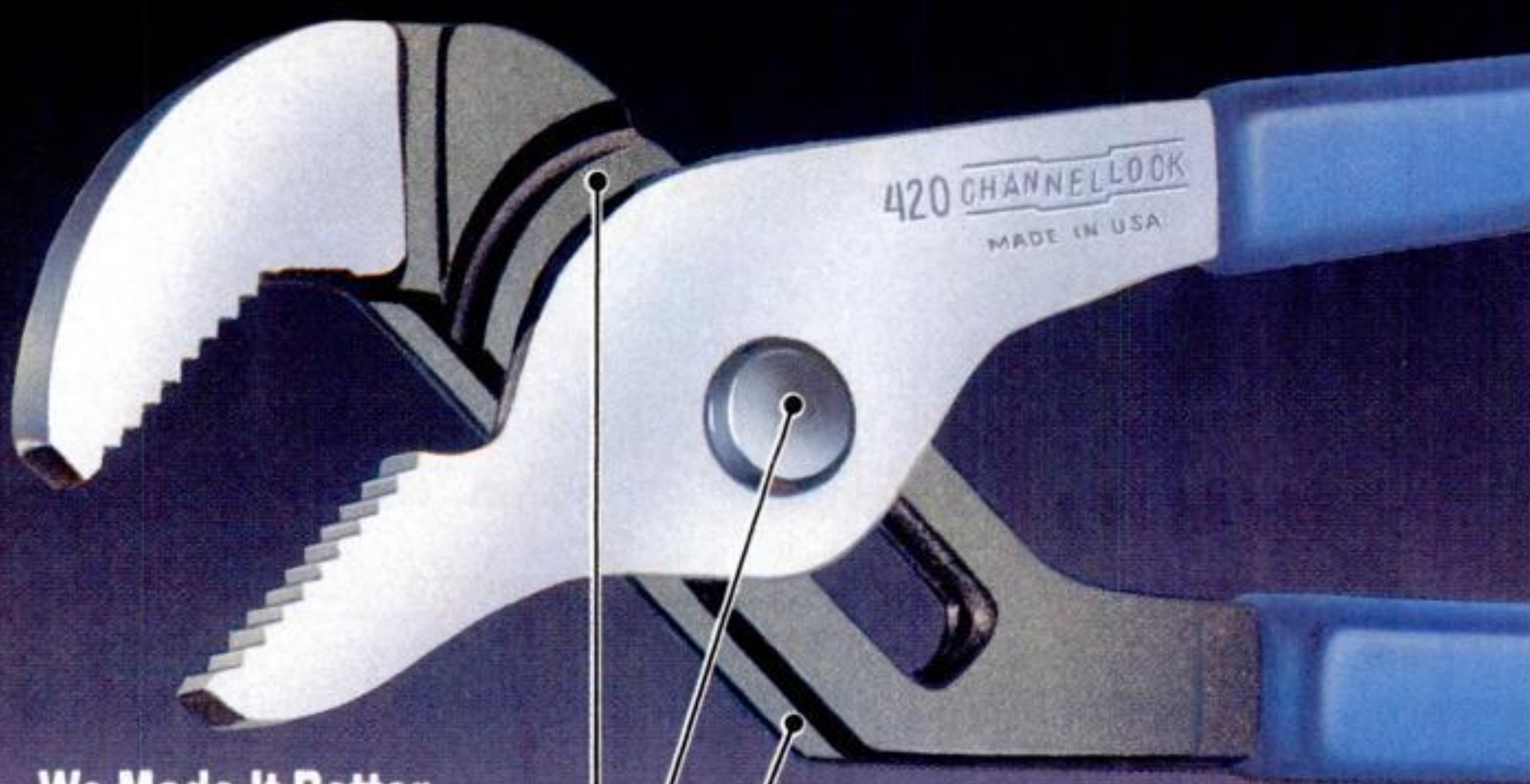
Chrysler's 4-Wheel-Drive Medallion

Chrysler will sell the Jeep Eagle sedan for another year then phase out that vehicle and replace it with a 4-wheel-drive Medallion. The timetable calls for the Medallion in the 1990 model year. That car will be imported from France and sold through Eagle dealers. Chrysler officials found that the average Jeep buyer is more affluent than the average buyer of a Chrysler product, so the AMC cars will be kept separate in showrooms.

Super Turbocharger

One of the biggest complaints against the turbocharger is the time lag between the driver depressing the accelerator and the delivery of power from the engine. The lag is caused by the need to rev up the turbocharger's blades. Researchers have been working on a system to cut down the lag time. It consists mainly of a way of directing exhaust gases against the blades more precisely, so that the pressure of the exhaust gas is stronger. In addition, variable blade angles is under consideration. Finally, lightweight ceramic blades, that have less inertia than metal ones and thus will respond more quickly to pressure, are being developed for mass production. All this is being done in response to the growing threat of a supercharger replacing the turbo. Toyota is already in the marketplace with a supercharged MR2 and next year Ford will put a supercharger in its premium Thunderbird, and change the Turbo Coupe into the Super Coupe. **FM**

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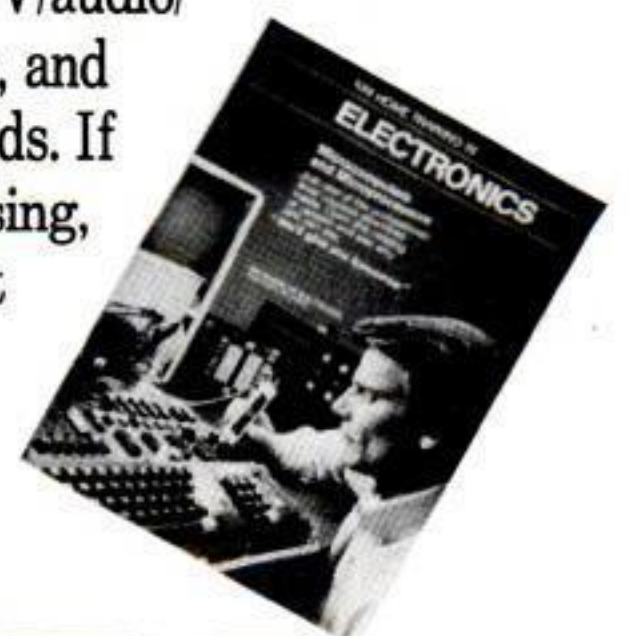
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HOME VIDEO

BY JAMES B. MEIGS

Minolta: Hands On

UNTIL recently, most home video camcorders have looked and worked like scaled-down versions of their professional counterparts. That's because most home camcorders are designed by electronics companies, such as Sony, Panasonic and JVC, that build the pro models, too. But there's more than one way to make a camcorder.

Minolta, the company whose Maxxum cameras brought autofocus to 35mm SLR film cameras, has begun to apply its still-camera experience to video. Minolta claims its new Master C-3300 camcorder

incorporates much of the autofocus, auto-exposure and light-metering expertise the company has acquired developing the

Maxxum and other products. During a recent hands-on workout of the Master camcorder, I got a



Zoom lens does not protrude from Minolta's camcorder.

chance to put those claims to the test.

The Minolta Master uses the VHS-C format, a cigarette-pack-sized minicassette that can play back either in the camcorder or, with an adapter, in any VHS VCR. But the choice of format isn't what makes this camera interesting. Minolta's innovative electronics and optics could be used just as easily in a VHS or 8mm camcorder.

At first glance, the Minolta Master doesn't look revolutionary: Its boxy and not particularly compact shape hides the sophistication within. It does have some interesting touches, though. The lens, instead of protruding from the front of the camcorder, is built entirely inside the handgrip that runs down the right side of the camera body. While most camcorders are designed to be operated almost entirely by your right hand—since that's how the pro models work—the Master gets your left hand into the act, too. The power zoom is controlled by an unusual round knob on the lower front of the camcorder. By forcing you to use both hands to operate the Master, Minolta's design virtually ensures shake-free movies.

But the Master's most exciting features are all inside. First, there's what Minolta calls "multidimensional autofocus," the only autofocus system that lets you focus on objects ranging from infinity to within millimeters of the front of the lens.

The autofocus system also uses a unique 2-phase method for finding the proper subject to focus on. When you aim the camera at an object in the center of the frame, the camera uses a narrow "window," identified by two tiny arrows in

(Please turn to page 39)

Nipper's Master's Voice Has A French Accent Now

RCA, the company that largely invented color television and is still the most popular TV and VCR brand in the U.S., is no longer in American hands. Nor for that matter, is the General Electric brand.

It seems RCA's home electronics division—once a mainstay of the company—has been getting handed around like a hot potato lately. First General Electric bought RCA back in 1986 and combined RCA's home electronics operation with its own. Now GE has sold off the combined GE-RCA consumer electronics division to the French company Thomson, one of the largest electronics manufacturers in Europe.

Selling off the RCA brand may have made good economic sense for GE. Making a profit selling TVs and VCRs is tough-sledding nowadays. (GE will hang on to the rest of RCA, including the lucrative NBC network.) But it's sad to see this country's premiere electronics brand—and mighty concentration of consumer electronics R&D talent—sold across the Atlantic. The sale leaves only Zenith as a major American manufacturer of TV sets.

Fortunately, the sale of GE-RCA's electronics division won't have much of an effect on consumers, at least not at first. Thomson has permanent rights to the RCA brand name,

but it will have to phase out the GE name within 10 years (in home electronics, the GE brand runs a distant second to RCA in popularity). According to Thomson's dynamic chairman, Alain Gomez, the company will continue to use the GE-RCA marketing organization, and the GE and RCA product lines will remain much the same.

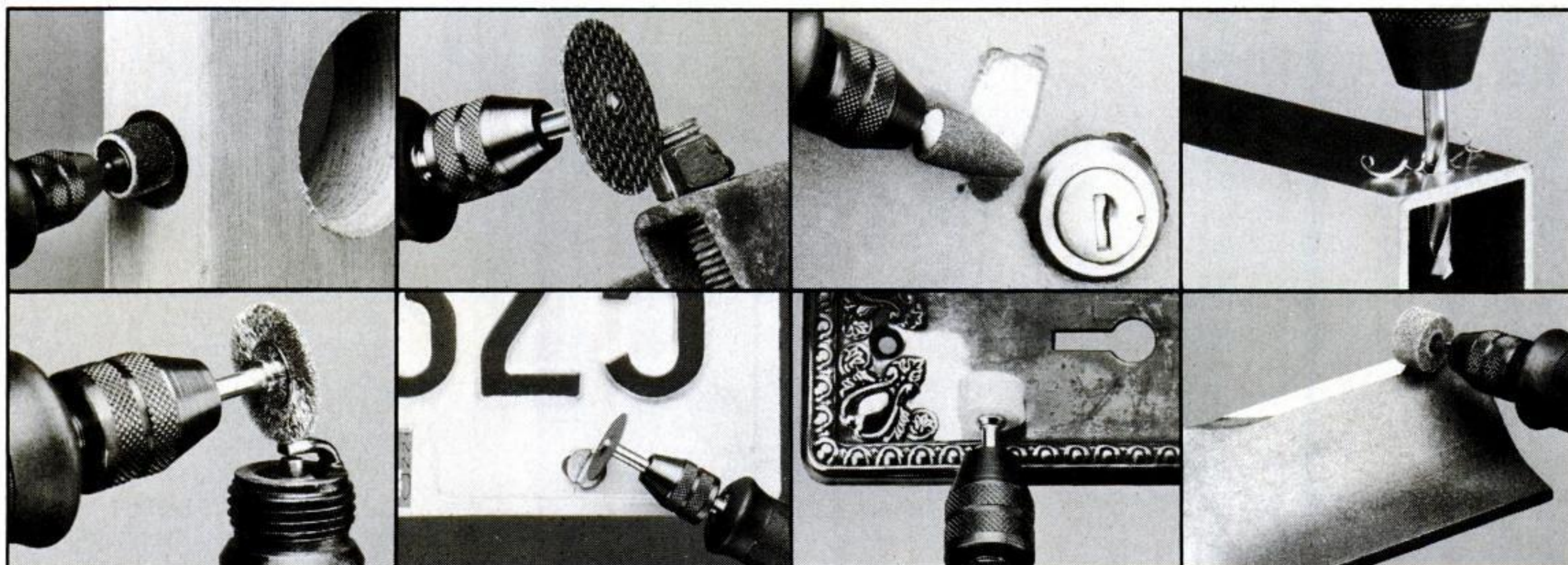
However, in the long run, Gomez says, the merger of GE-RCA and Thomson could have a major impact on the types of technologies we find in our homes in coming years. At the New York press conference announcing the move, he stressed that Thomson wants to combine GE-RCA's substantial R&D capabilities with Thomson's own, making the company one of the world's leading electronics innovators.

In addition, the sheer size of the GE-RCA-Thomson combination will give the company a great deal more clout in negotiations over future TV and video formats. For example, in the sharp debates over high-definition television (HDTV), Thomson and other European companies have opposed the 1125-line system proposed by the Japanese. They favor instead a system that would bring the benefits of HDTV to purchasers of HDTV sets without making all current TV sets obsolete.



Original "meatball" logos of RCA and GE. *Au revoir!*

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HOME VIDEO

(Continued from page 37)

the viewfinder, to determine that the camera focuses on that object. But if the object moves out of that window, the camera doesn't automatically focus on the background. Instead, it expands the window—the tiny arrows in the viewfinder suddenly move apart—while it searches laterally for the roving subject. In theory, that should keep the camera from drifting out of focus every time the subject you're shooting moves slightly off-center.

Most camcorders include a "backlight compensation" button, an adjustment that brightens the foreground of a scene that has too much light behind—a person's face against the sky, for example.

But the Minolta does those models one better by making the backlight function completely automatic. Just as with many film cameras, the camcorder senses the lighting imbalance between subject and background, and adjusts exposure to favor the subject. Now that's the way to make a fool-proof camcorder!

So how well do all these fancy features work? During my workout with the camera I was impressed with Minolta's accomplishment. The automatic backlight function worked flawlessly, and the autofocus system was indeed able to focus right up to the surface of the lens. During one shot, I had left the camcorder on the floor and a friend's cat suddenly walked right in front of it. The camcorder took that in stride: The cat's whiskers snapped into focus in what seemed like a split second. In fact, the Minolta Master has the most responsive and fast moving autofocus I've ever seen.

Unfortunately, sometimes it seems a little too responsive. When shooting a scene with lots of potential targets to focus on—such as a group of people—the camcorder seems to hunt in and out instead of settling on an adequate compromise. Minolta says it is working on this quirk, and when the upgraded Master arrives ear-

ly next year, it should feature a lot less hyperactive autofocus. Overall though, Minolta deserves kudos for this intelligent rethinking of camcorder technology.

Space Saver

Multibrand remote controls—which started out as expensive, complicated devices—are getting cheaper and easier to use all the time. The latest comes from Zenith, the company that invented TV remote controls back in 1956 with its Space Commander.

Called the Personal Control Center, this \$40 universal remote offers immediate remote control of at least 18 color TV brands and 19 VCR brands. And, unlike some earlier universal remotes, this one doesn't have to "learn" the codes of your current remote controls in some complicated programming process. All the codes your equipment is likely to use are already programmed into the remote's memory.

The Personal Control Center offers another plus too. Because Zenith is a major manufacturer of cable TV equipment—in fact, this product comes from Zenith's cable engineers and will be sold by cable companies around the country—this remote is geared to the needs of cable subscribers. Not only does it control Zenith cable converter boxes, it also has the codes to remotely control seven other common cable boxes.

With products like this, there's no excuse anymore to have three or four remote controls cluttering up your coffee table.

Camcorder College

It's not often that a book can offer up-to-date information on video products. The field just changes too quickly. But a new book on buying and using video camcorders, *The Video Camcorder Handbook*, manages to be both timely and informative. Written by two long-time video experts, Marjorie Costello and Michael Heiss, the book includes chapters on all the latest gear—including the new Super VHS models.

Even if you already own a camcorder, *The Video Camcorder Handbook* offers some useful tips on lighting, shooting technique and other ways to improve your home movies. It's not necessary to know just how a camcorder works to use one properly, but if you are interested, this book also includes some of the best explanations of video camera and recorder technology I've seen. It's available in bookstores or from HPBooks, Box 5367, Tucson, AZ 85703, and costs \$14.95 plus \$1.95 for postage and handling.

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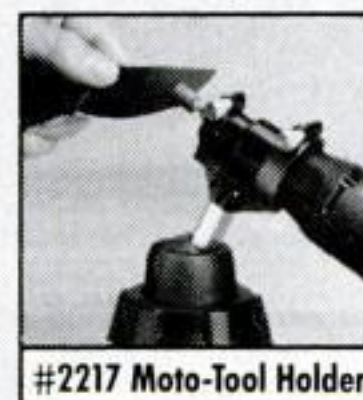


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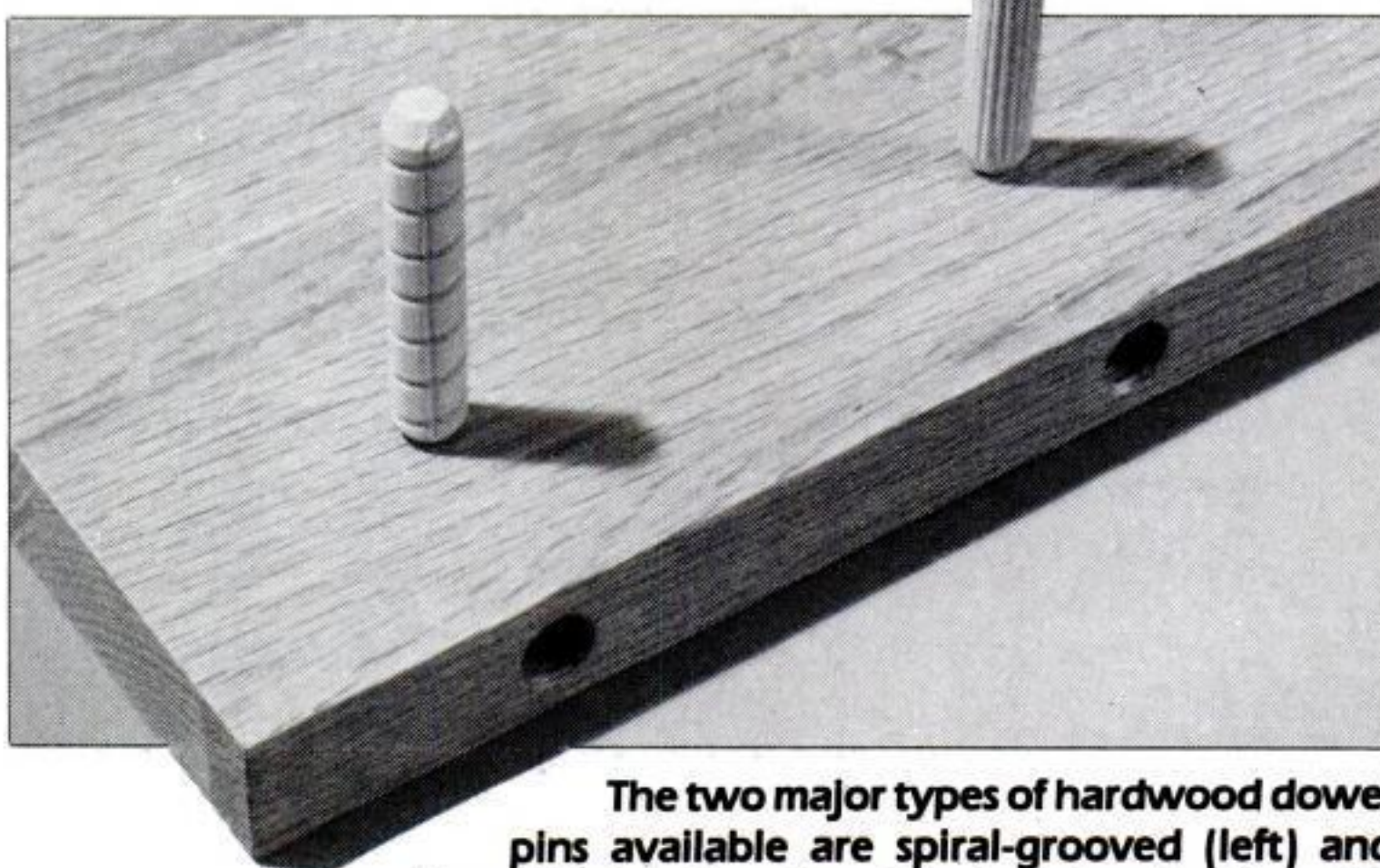
BY ROSARIO CAPOTOSTO

Using Dowel Pins

OF the many joints used in woodworking, one of the most popular is the dowel-reinforced joint. Doweled joints are simply butt or miter joints that are reinforced with hardwood dowel pins.

Dowel pins, usually made of maple or birch, are commonly available in $\frac{1}{4}$ -, $\frac{3}{8}$ - and $\frac{1}{2}$ -in. diameters and in lengths of $1\frac{1}{2}$, 2 and $2\frac{1}{2}$ in. Dowel pins have chamfered ends and spiral grooves or flutes cut in their surface. The grooves or flutes are necessary to allow air and excess glue to escape as clamping pressure is applied. Hardwood dowel pins are sold at hardware stores and through mail-order woodworking catalogs.

You can also make your own dowel pins from com-



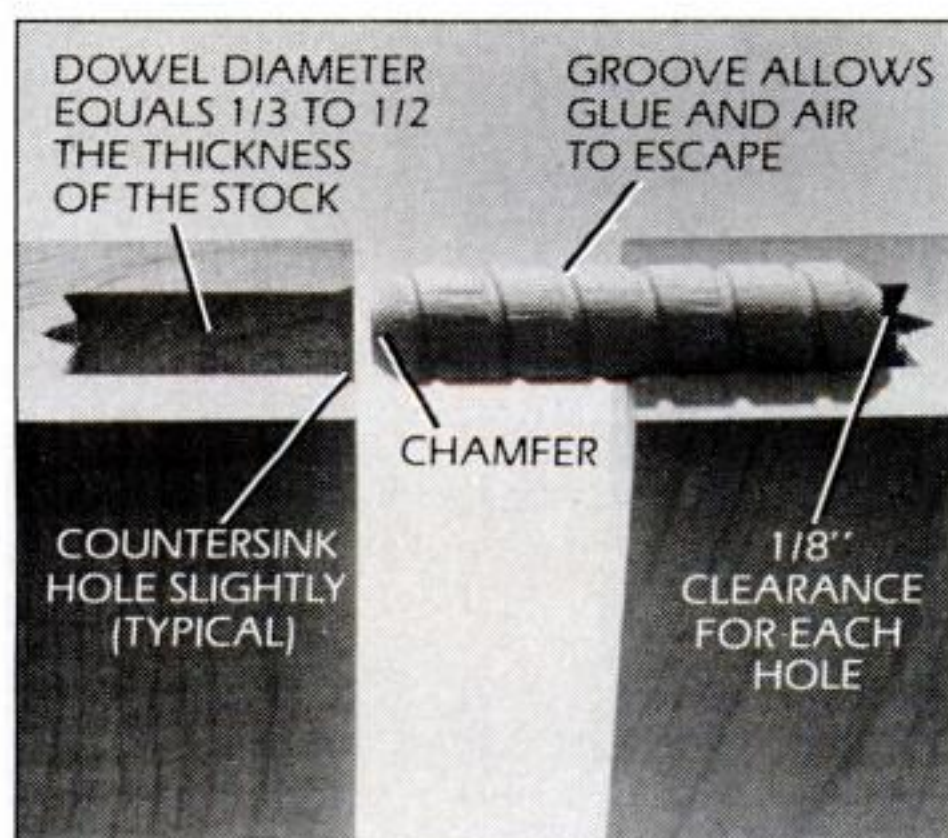
The two major types of hardwood dowel pins available are spiral-grooved (left) and fluted (right). Chamfered ends make pins fit easily.

mon dowel rods. Hardwood dowel rods, sold in lumberyards and hardware stores, come in various diameters usually in 3-ft. lengths. However, you must cut grooves or flutes in the dowel rod to allow air and glue to escape.

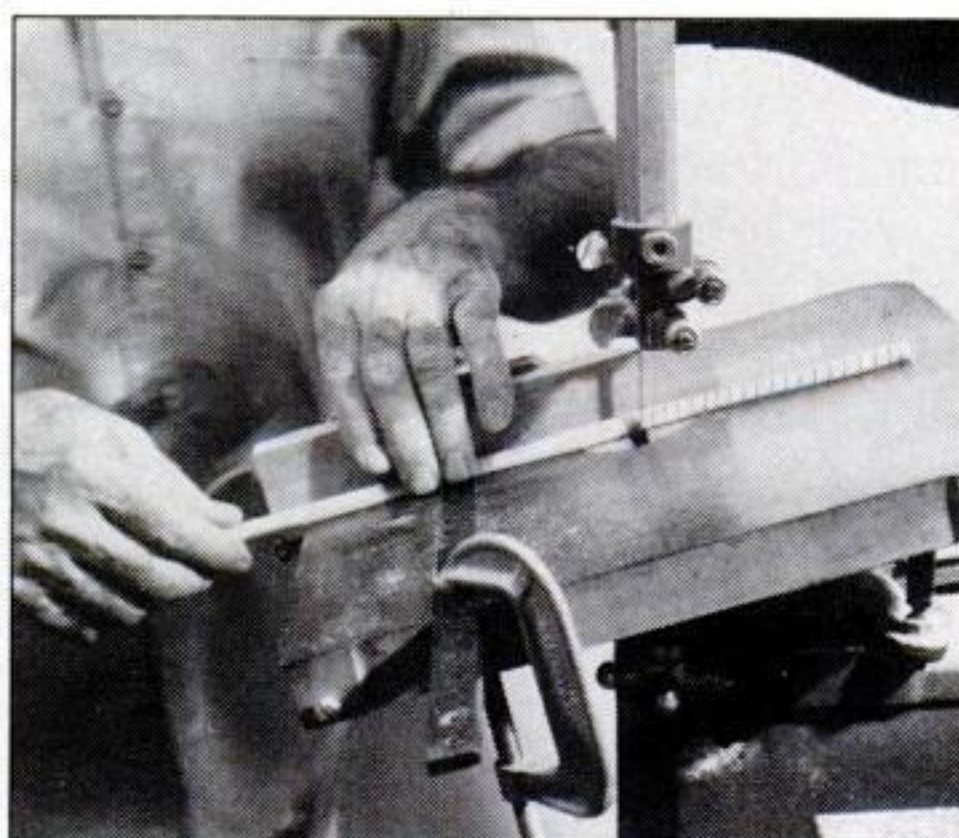
Spiral grooves are most easily cut on the band saw, as shown. Tilt the saw's worktable about 15° and clamp the miter gauge in place so that the blade cuts $\frac{1}{16}$ in. deep into the rod. Now, start the saw and slowly rotate the rod back

toward you. It will advance automatically up the worktable. Then, cut the rod into pins of the desired length. To cut flutes in a pin, make the fluting jig shown. Bore a hole in a wood block equal to the dowel pin diameter. Grind sharp points on two 8d common nails. Drive one nail into each side of the block so that the nailpoints protrude into the hole about $\frac{1}{16}$ in. Drive the dowel through the hole with a hammer and drift pin. The protruding nailpoints will cut flutes in the dowel. Rotate the dowel slightly and drive it through the hole again. Repeat until the pin is completely fluted.

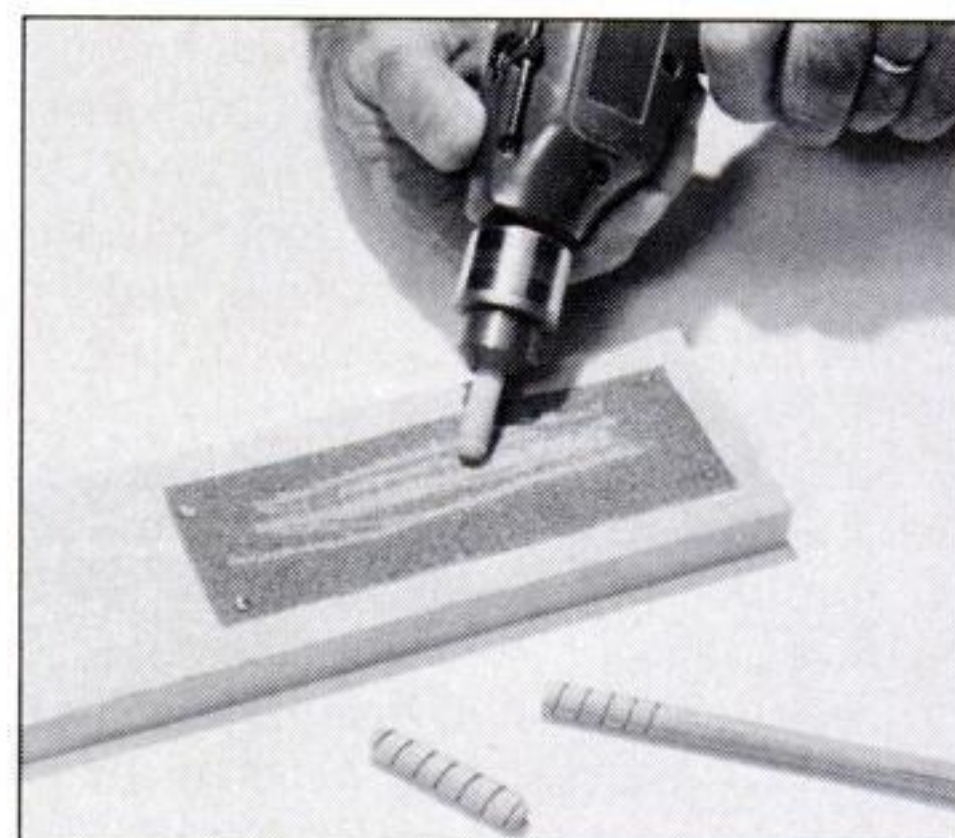
I've found that shopmade dowel pins are every bit as good as the store-bought kind. **PM**



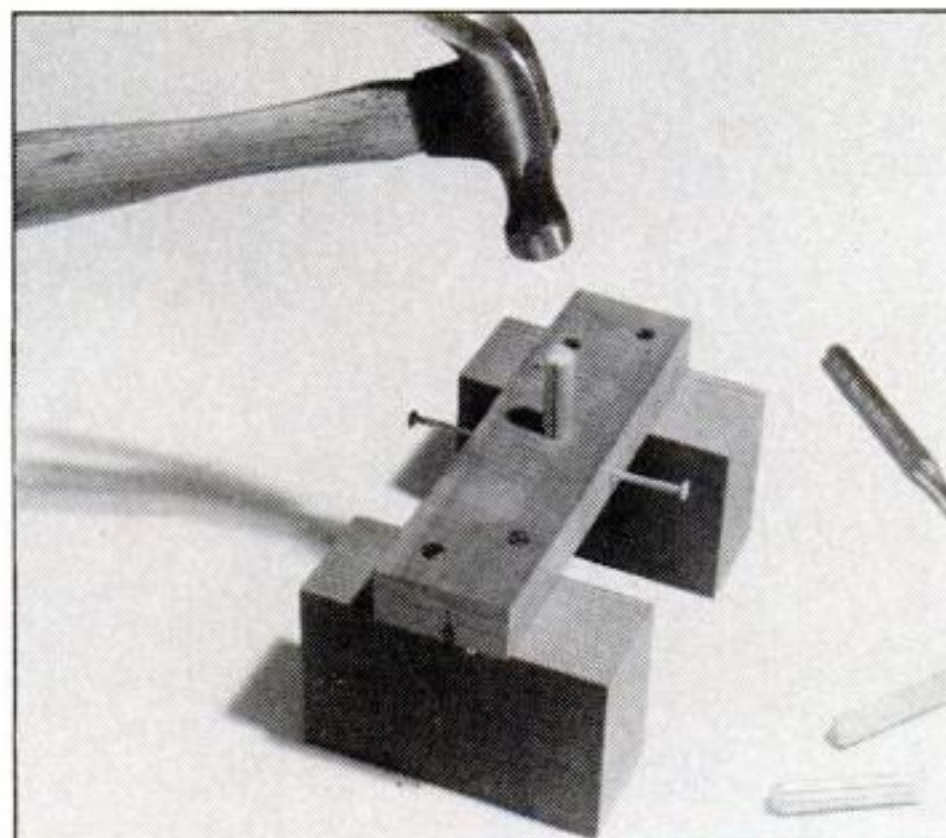
Here's a cutaway of a typical dowel joint. Bore each hole slightly deeper, about $\frac{1}{8}$ in., to prevent dowel pin from bottoming out.



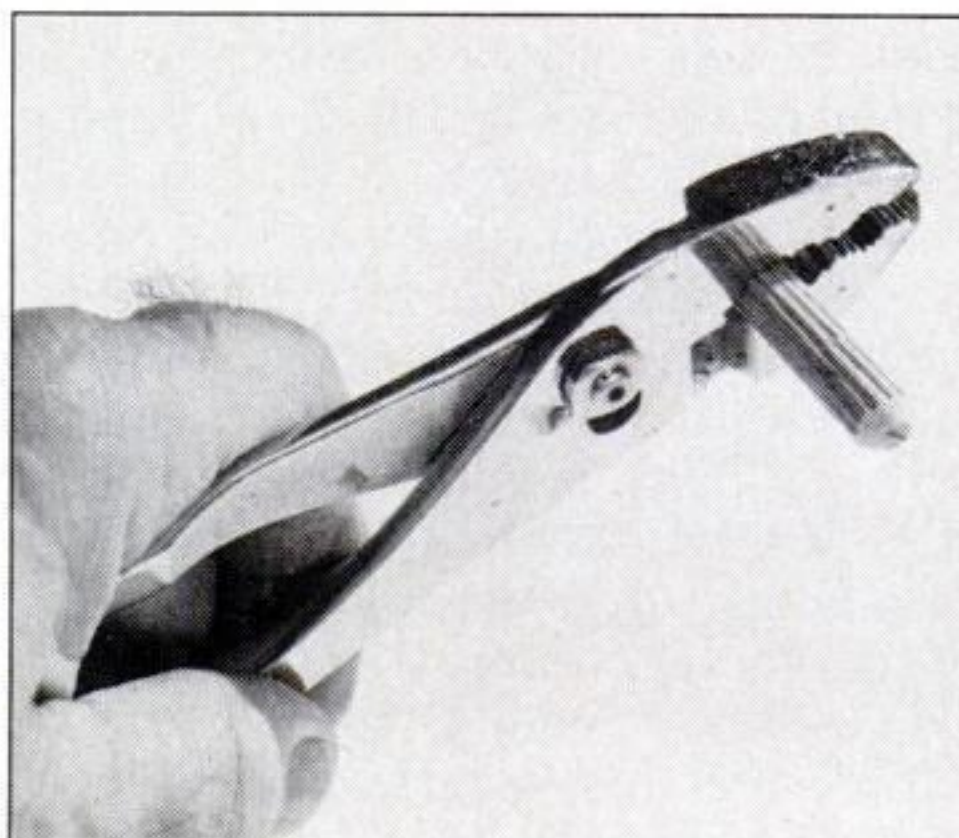
Make spiral-grooved dowels on a band saw. Tilt table and clamp miter gauge in place. Rotate dowel rod backwards to cut spiral.



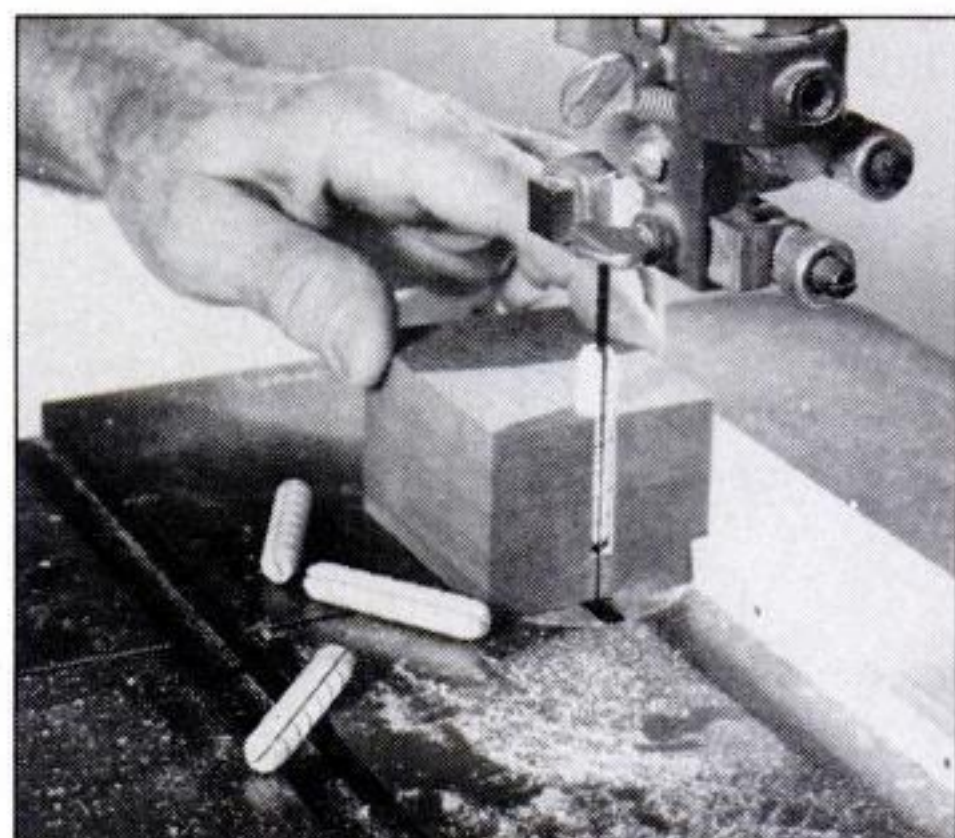
To chamfer ends of shopmade dowel pin, chuck pin in a drill and spin it on 80-grit sandpaper. Secure the sandpaper with tacks.



Make this jig to cut flutes in dowel. Drive in nails so points protrude into hole about $\frac{1}{16}$ in., then hammer dowel through hole.



Slip-joint pliers can also be used to form flutes. Use curved, jagged-tooth portion of jaws to squeeze dowel pin and form flutes.



Using a shopmade jig, cut $\frac{3}{4}$ of the way through a dowel. Use these dowels to dry-assemble parts—they won't stick in holes.

A photograph of three young adults in a rustic setting. A man in a plaid shirt and jeans is leaning over a large wooden cabinet, holding a cigarette. A woman in a yellow sweater is sitting on the steps, holding a wooden crate. Another man in a blue jacket and cap is sitting on the steps, looking up at the man with the cigarette. The scene is set against a brick wall and a large wooden cabinet.

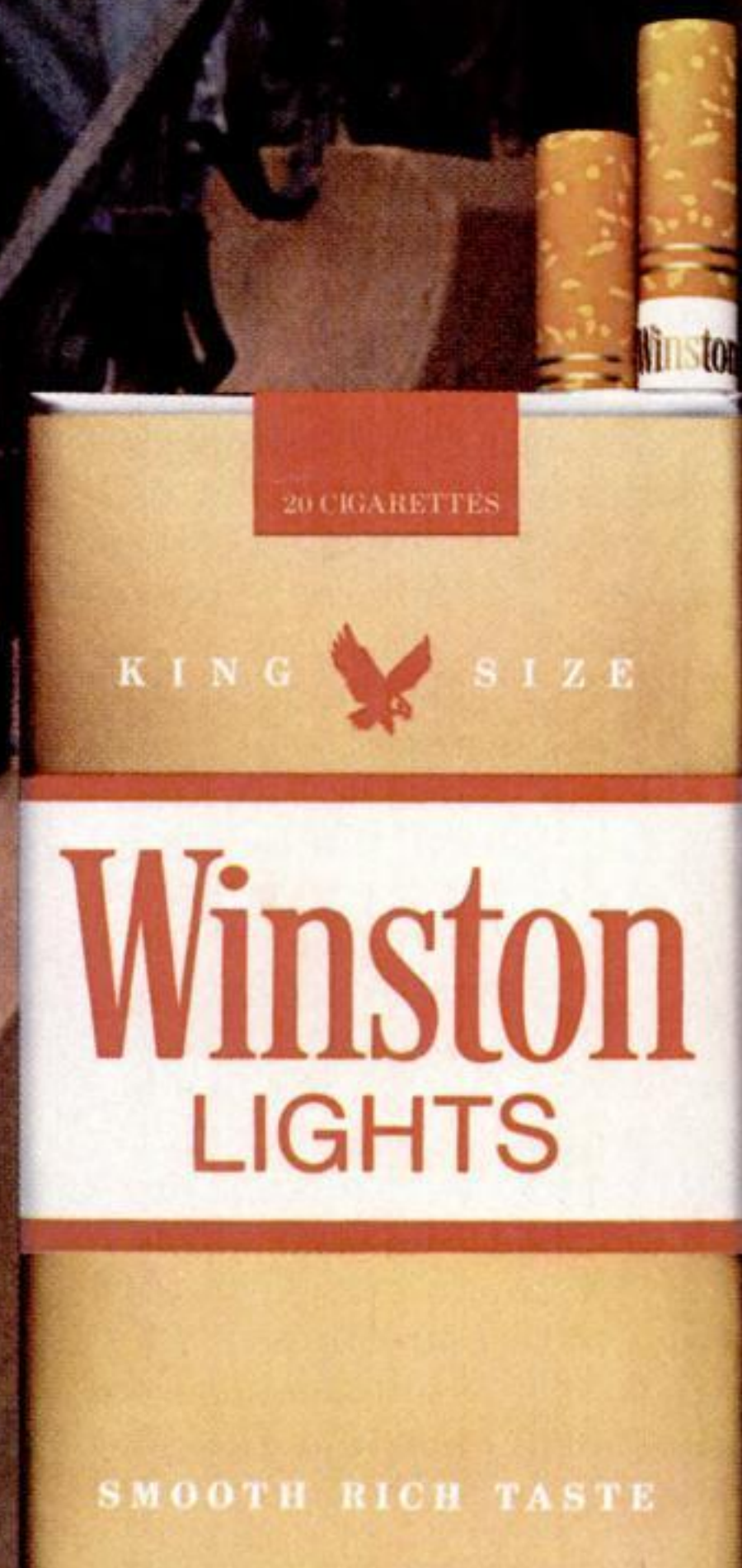
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Oceans On The Brink

JOHN Fine and I purged the air from our buoyancy compensators and slowly submerged into the enveloping gloom of Long Island Sound. Breathing easily from the single scuba tanks strapped to our backs, we made our way steadily downward in the dwindling light—until a bloom of brown algae brought the curtain down. Blackness—utter and absolute—filled the senses as we groped our way to the bottom. Finally, with the cloud of algae hovering overhead, we knew we had arrived at our destination—a submerged ledge at a depth of 40 ft.—when we ran into a discarded lawn chair and a collection of rusty soft-drink cans.

Amid reports of declining conditions in Long Island Sound—including massive fish kills in anoxic tributaries and tremendous algal growth—John and I were seeing first-hand the effects of urban environmental pressures placed on an important natural resource. Forty-two municipalities ringing the 100-mile long Sound deposited billions of gallons of sewage—treated and untreated—into the inshore water last year. Sanitation officials in several locations cite equipment breakdowns for the tons of raw effluent that made its way into the Sound. The brown algae flourished in fecal matter and the unusually warm surface temperatures. When the algae died, the process of decay used up the oxygen in the water, which affected the Sound's vast food chain. Pollution forced the closing of more than 200,000 acres of shellfish grounds in New York State. The "brown tide" virtually eliminated the scallop industry. The year before, PCBs all but ended



Cole (left) and author John Fine before a dive on Long Island Sound.

striped-bass fishing.

John Fine stands as sentinel as a succession of environmental disasters like the one facing Long Island Sound slowly strangles the quality of nature in America. John's recent book, *Oceans In Peril* (Atheneum, \$15.95), is both a chronicle and a warning of the consequences of our continued misuse of the sea. From toxic landfills in Elizabeth, New Jersey, to agricultural runoff in the Red Sea, John pinpoints a variety of pressing environmental dilemmas.

They all have a common element. The relentless intrusion of humanity on the natural world.

Consider: • Sewage residue, industrial chemicals, polluted harbor dredgings and ash continue to be dumped in the Atlantic 12 miles off the crowded beaches of Long Island. • A slick of medical waste, including syringes and blood samples, washed ashore last summer on New Jersey's barrier beaches. • Sea birds at Kesterson National Wildlife Refuge south of San Francisco are being born with hideous deformities, including stubs for wings and legs, beaks like corkscrews, no eyes and protruding brains. Trace elements of seleni-

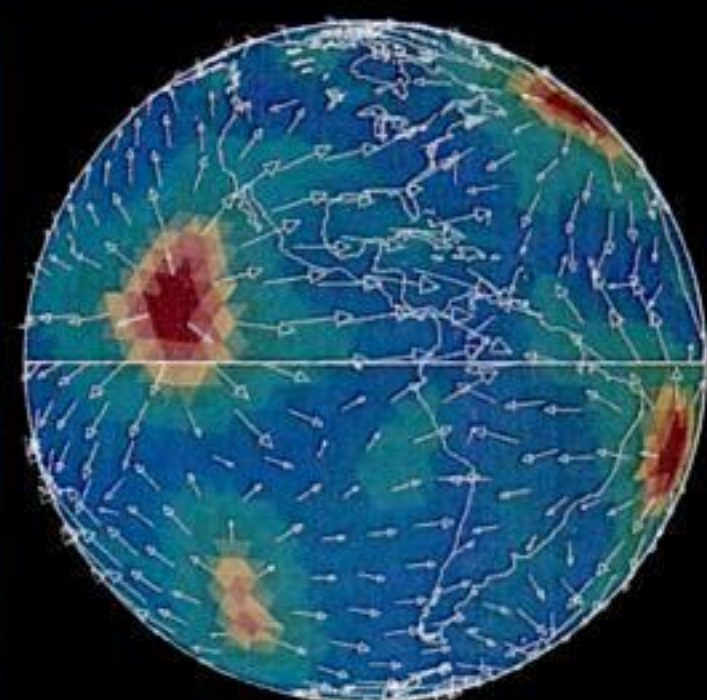
um, mercury, boron and arsenic are believed to be the cause. • Tissue samples from dead pelicans at the Stillwater Wildlife Management Area east of Reno, Nevada, indicate similar concentrations of trace elements—some as high as 51 parts per million. Long Island Sound is one of John's principal concerns, however. Recent dives have revealed significant, long-term damage.

"We've run across dead flounder, eels that are dead or dying, unable to move, their mouths opening and closing in a vain attempt to push oxygenated water through their gills," he says. "In several areas the lobster population is completely dead. Small and large lobsters that once used shipwrecks as a secure habitat are out on the decks, some on the highest parts of the wreckage. The few of them that are alive are lethargic and don't move when we touch them. Hundreds of lobsters lay dead in the silt, victims of a lack of oxygen."

As John and I returned to our boat on the surface, we took with us the image of a horseshoe crab struggling in the brown current. Clinging to life, it symbolized faint hope in this sea of recurring trouble.

Continental Drift

Plate tectonics and the resulting migration of the sea floor is widely accepted as the means by which our continents were formed. A worldwide thermal exchange in the planet's silicate mantle is thought to have caused this continental drift. To confirm this 25-year-old theory, John R. Baumgardner at the Los Alamos National Laboratory is developing a 3-D computer process that mathematically duplicates the Earth's geologic history. Baumgardner has divided the Earth's surface into 81,920 3-dimensional triangles connected by 43,554 nodes. Using a Cray supercomputer, Baumgardner is able to minutely analyze each triangular segment, taking into consideration earthquakes large and small, and fault-zone activity no matter how significant. The actual seismic history of each segment is taken into account, along with the known thermal dynamic of the Earth's silicate magma. The experiments have shown how temperature imbalances created circulation patterns in the



A computer model of Earth.

mantle over time.

"I'm convinced we're on the right track," says Baumgardner. "We're beginning to understand the essential mechanisms that could have caused the continents to drift apart." **FM**



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BY STEPHEN A. BOOTH

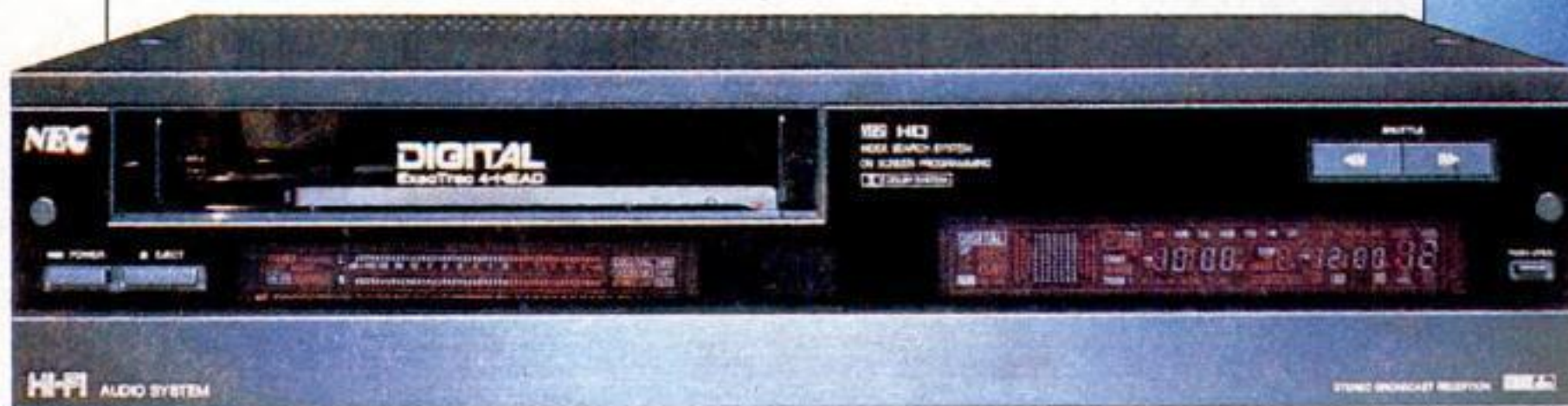
Electronics Emporium



Franklin's Spelling Ace.

THE number of electronics products introduced each year tallies quite literally in the thousands. To keep track of them, our Electronics staffers attend the two semi-annual Consumer Electronics Shows in the U.S., plus the yearly

Spelling Ace by Franklin Computer can help. Use the keyboard to spell the word phonetically, as best as you can, and the Ace will present you a list of correctly spelled alternatives from its 88,000-word vocabulary. It's great for cross-

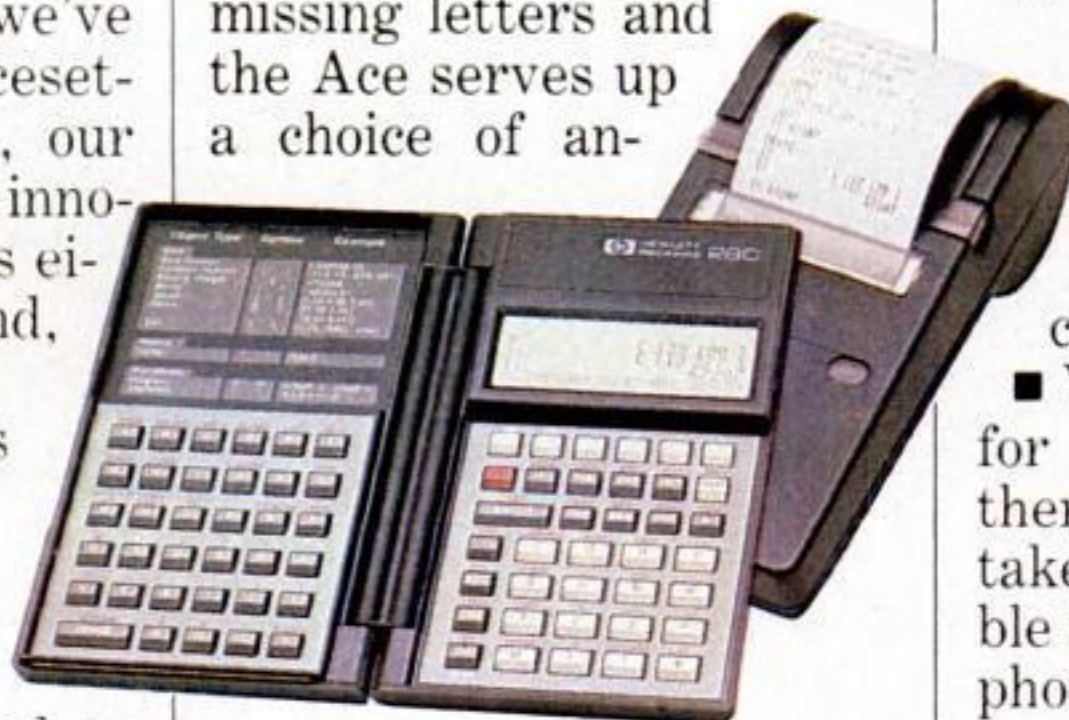


NEC's new VCR, DX-5000U, has digital noise-reduction.

tradedfest in Japan. Amidst the cornucopia of new items there are always a few standouts, and here we've singled out these pacesetters. As in the past, our judging criteria prizes innovation. The product is either the first of its kind, or advances the state of the art, or provides a meaningful service to the owner. Our congratulations to the winners!

■ A dictionary is hard to use if you don't know how to spell the word in the first place. Here's where the

word puzzles, Scrabble or other games: Simply enter question marks for the missing letters and the Ace serves up a choice of an-



H-P calculator has IR printer.

swers. The \$90 wonder is about the same size and weight as a paperback.

■ So-called digital VCRs often give you little more than gimmickry, such as picture-in-picture, or improved special effects such as freeze-frame or slow motion. But NEC Home Electronics has put digital technology at the service of better video quality in its

DX-5000U deck (\$1200). Instead of gee-whiz effects, the VHS deck uses digital signal processing to remove snowy video noise from less than perfect tapes. These include programs recorded



Minolta has the Maxxum of 8mm camcorders.

at the slow (EP) speed, or much-used rental tapes, or recordings made from poor program sources (such as weak or interference-plagued TV reception). The improvement is quite visible and, in marginal reception areas, you can use the DX-5000U's tuner for improved broadcast TV.

■ Whether the research is for business or school, there are only two ways to take notes: You can scribble them by hand, or make photocopies. Photocopying

Aiwa convertible camcorder has monitor, remote.



Ultimate universal remote, from CL-9.

is easier—but often you've got to wait in lines, shell out change, or copy a whole page when you only need a handful of key sentences. Sharp's Z-HC1 Handy Copier (\$190)

uses a pen-like scanner wand that lets you take down only what you want. It's attached to a separate thermal printer that displays your notes in neat columns—and can even mag-

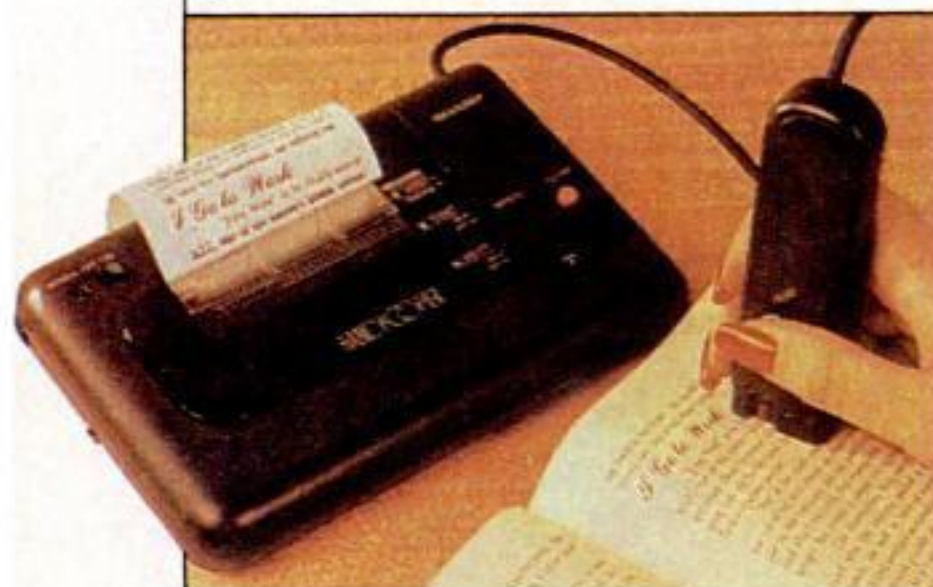


Regency's public info radio.

nify them to two times their original size. In its graphics mode, it copies artwork too.

■ Hewlett-Packard introduced the

(Turn to 46)



Handy Copier, by Sharp.



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ELECTRONICS EMPORIUM

(Continued from page 44)

world's first handheld scientific calculator just 15 years ago. The company's latest pocket brain, the HP-28C, can do things that were barely imaginable then. For example, the \$235 calculator can perform symbolic math, using symbols or variables instead of real numbers. You can program equations into its memory, punch in the variables, then see your results on a printer (\$135) connected by infrared light. ■ Most camcorders are designed and made by electronics companies. But Minolta takes full credit for its Master Series C-3300, so the VHS-C camcorder shows Maxxum-like innovation on the camera end. The autofocus lens tracks moving subjects gracefully, while the light-metering system exposes them perfectly. Its front-mounted zoom control promotes shake-free handling.

■ Credit Sony's original Handycam as the Walkman of 8mm video camcorders. You could palm it like a midjet football and make two hours worth of great movies—but you needed a separate, tabletop playback deck to watch the tape on your TV. Now, Aiwa's CV-50 (\$1300) camcorder gives the portability of Handycam

plus the convenience of playback. The record-only moviemaker comes with a snap-on module that converts it into a playback VCR. Another \$200 buys a wand-like remote control with 2-in., black-and-white TV tube for monitoring in the field.

■ The hottest thing in remote controls isn't just infrared wireless: It's universal control—the ability to operate multiple components of different brands with a single handset. CL-9 goes one better. The \$200 CORE, developed by Apple Computer co-founder Steve Wozniak, adds a timer that lets you program the operation of infrared-controlled components that lack one. Programming is simple, usually via a single touch command.

■ Regency calls its Informant INF-1 "public information radio." Unlike conventional scanners, the mobile receiver (\$370) is preprogrammed to tune in police and emergency frequencies (VHF and UHF) in any state. Select the state and the radio does the rest, scanning 40 channels a second in a 50-mile radius. There's a home version too, INF-5 (\$350).

D-I-Y 3-D—Almost

It's been a long time coming, but the momentum for 3-D videography has been building during this past year to

the point where we'll see some home products in the months to come. As our August feature story noted ("3-D TV Comes Home," page 66), some 3-D videogames and computer programs already have made their debut. And in Japan, stereoscopy buffs can buy 3-D videodiscs that become viewable on a regular TV when the viewer wears special LCD shutter glasses. A VHS videocassette version, from Sharp, also has been developed.

With any of these 3-D video products, the programming has to be store-bought: There's no way you can roll your own. Until, that is, Toshiba puts a price tag and delivery date on the 3-D camcorder it recently unveiled in Japan.

Toshiba calls the product "3D-CAM" and says it will record on the mini VHS-C cassette. The 4-pound camcorder has two CCD image pickups fed by two lenses that are spaced apart like human eyes, to achieve the stereo effect. The images are viewed with LCD glasses, but to eliminate flicker, Toshiba doubles the field scanning rate from 60 to 120 per second. Accordingly, the connected TV must scan at twice the normal rate.

At first, Toshiba will sell the camcorder to commercial users. It's shooting for a \$2000 price tag. **PM**

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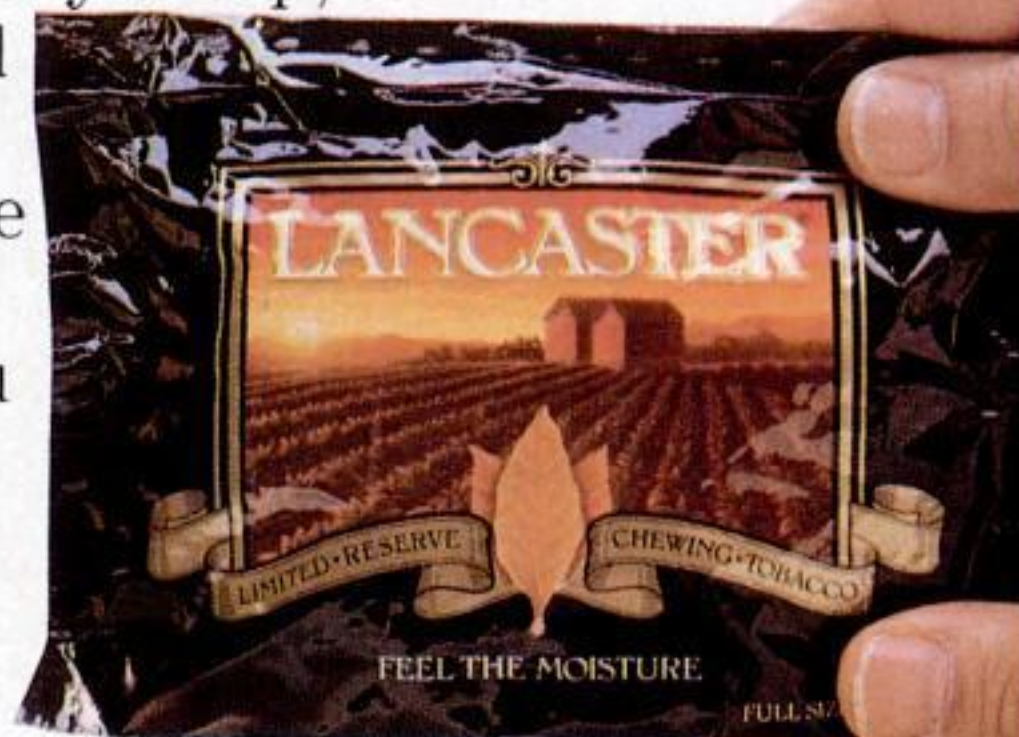
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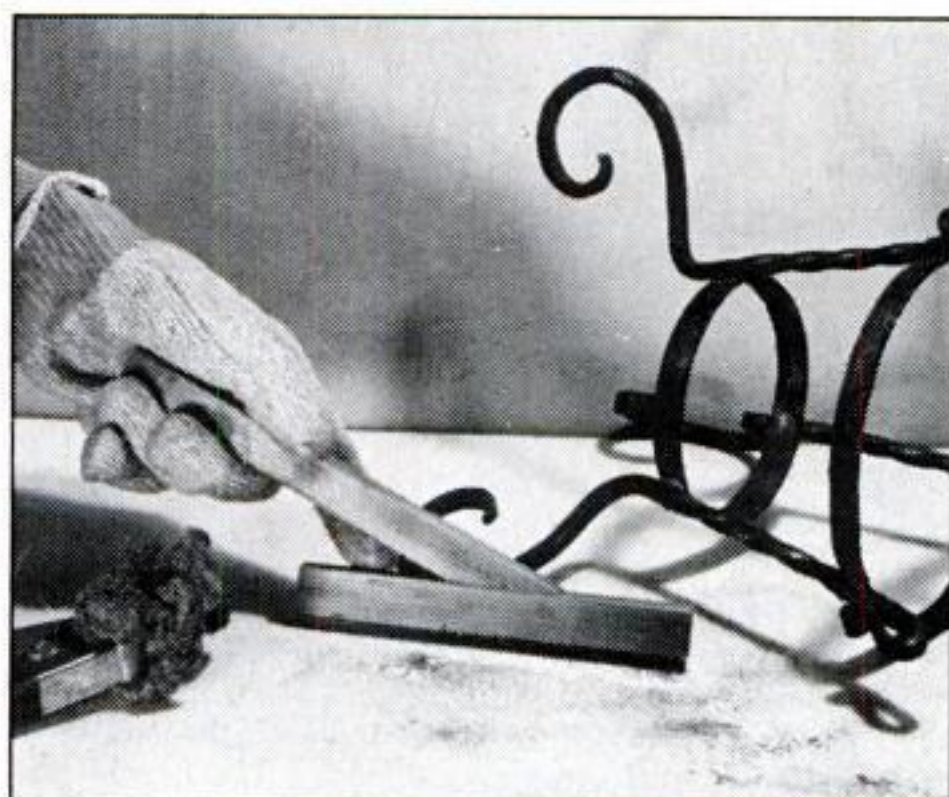


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HINTS FROM READERS

Attractive Cleaner

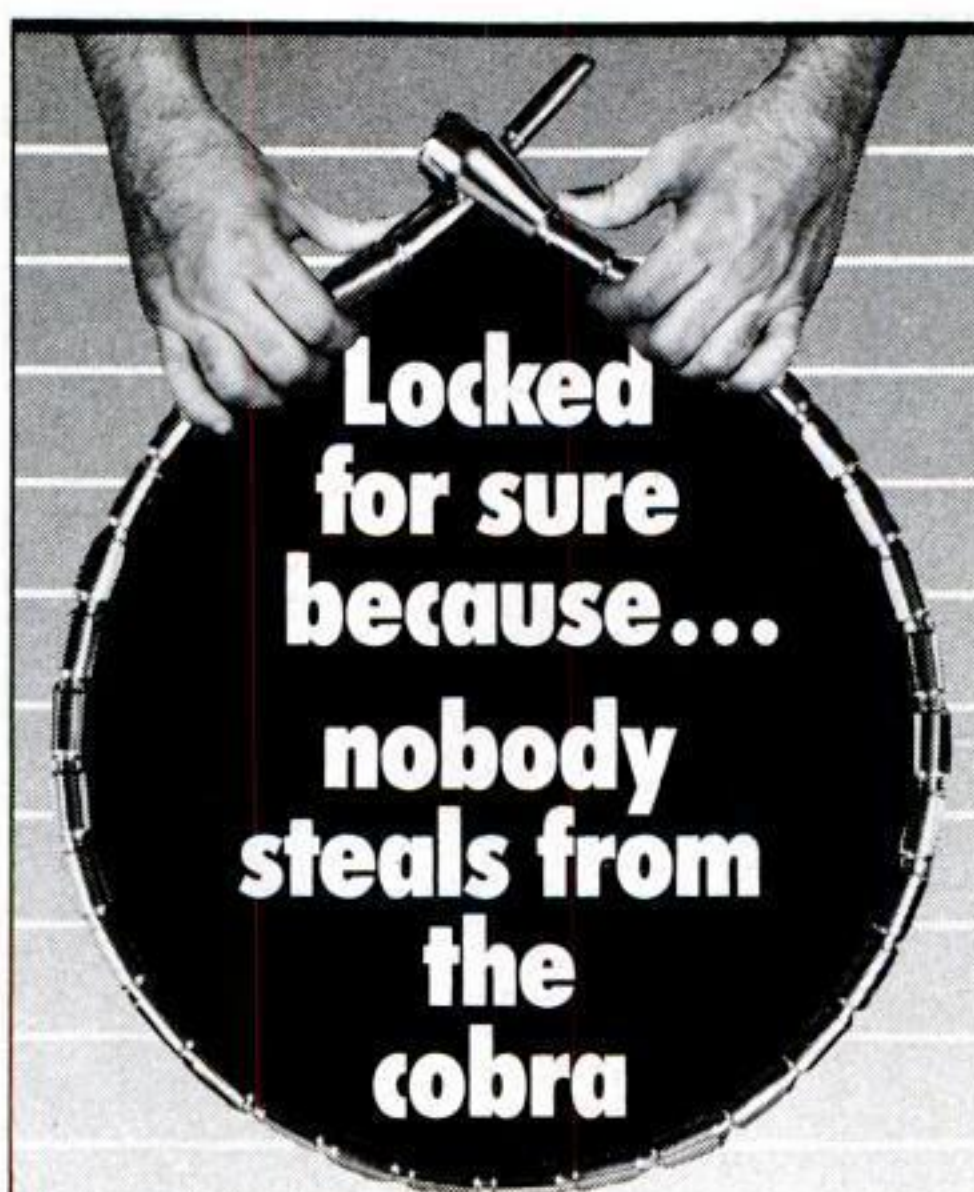
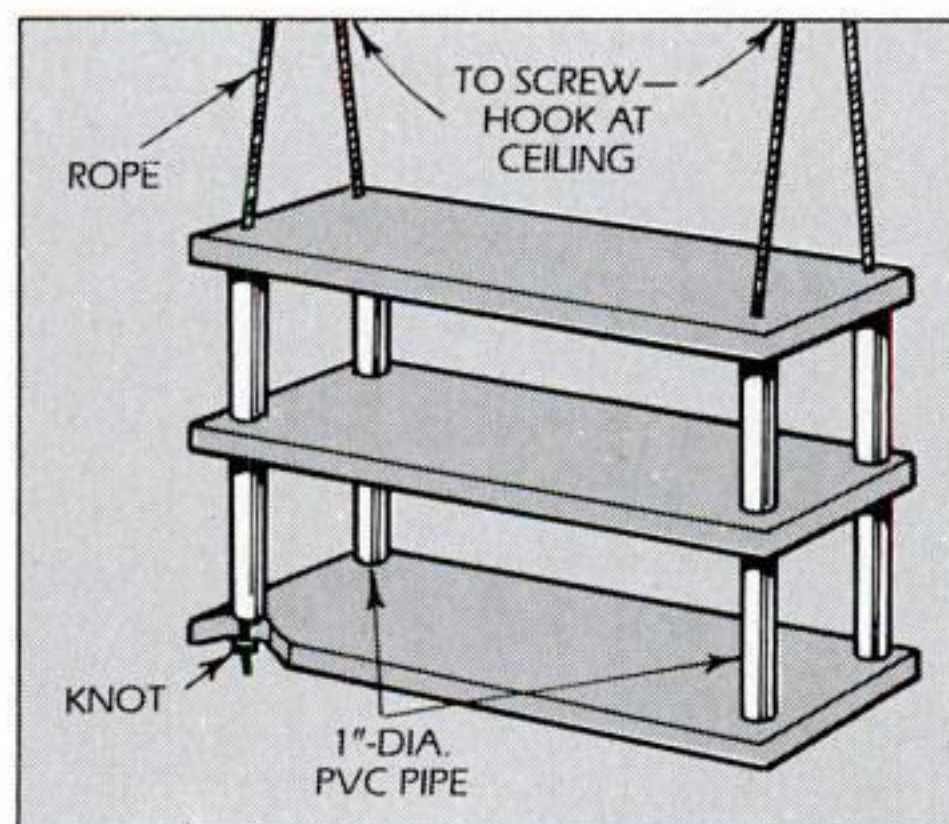


After using steel wool for cleaning surfaces to be painted, use this magnetic clean-up tool to remove all the small steel particles that remain. Make the handle and base out of $\frac{3}{4} \times 1$ -in. stock. Trim one end of the 8-in.-long handle to about 25° and nail and glue it to the 6-in.-long base. Then glue a flexible magnetic strip to the base with fast-setting epoxy or contact cement. After use, clean the magnetic strip with a disposable damp cloth.—*Walter E. Burton*

Hanging Shelves

Hanging shelves seemed like just the thing for my daughter when she went to college. Conventional hanging shelves use four knotted ropes that support the shelves. The assembly is then hung from screwhooks in the ceiling. I found it next to impossible to position the supporting knots accurately so all the shelves were parallel and level. To solve this problem I spaced the shelves with 12-in. sections of 1-in.-dia. PVC pipe. Only one knot at the end of each rope is needed. Thread the ropes through each shelf and spacer and adjust for level when tying to the screwhooks.

—*Garry A. Cornell*



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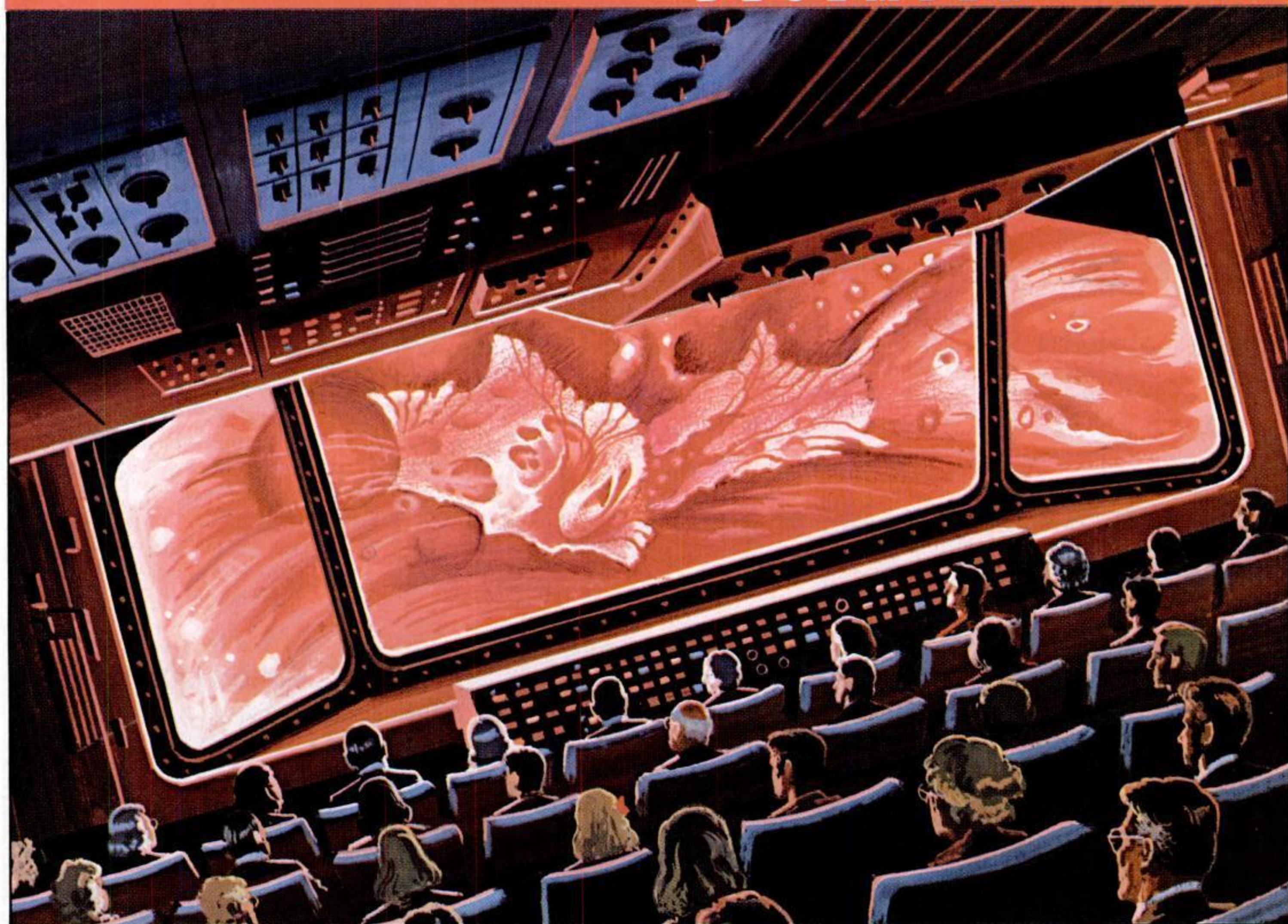
Your team will be responsible for transforming a spot of wilderness into a satellite communications station. One capable of sending and receiving messages anywhere in the world. If you qualify, you'll be trained to work with microprocessors, troposcatter and microwave communications equipment, single-and multi-channel systems, and more. High tech doesn't get much higher than this.

If the challenge of preparing one of our dishes gets you hungry for some exciting high-tech learning, call toll free, 1-800-USA-ARMY, or talk to your local Army Recruiter.

ARMY. BE ALL YOU CAN BE.

PM TECH UPDATE

DECEMBER 1987



Ride Through The Human Body

ORLANDO, FL—Passengers will have to be strapped into their seats inside the 40-place “theater” to embark on this tour through mind and matter. The attraction is part of Walt Disney World’s Life and Health Pavilion, to open at EPCOT Center in October of 1989. It’s based on the fully motion-capable flight simulators used to train today’s pilots. Similar to the Star Tours attraction at California’s Disneyland, “Body

Wars” will move passengers up, down and sideways, while an animated film of the human immune system rolls on a wide-angle screen. Passengers get a real-life sensation of moving through the circulatory system, past the heart, into the lungs, and finally into the brain—complete with firing neurons and raging electro-chemical storms. Action on the screen is synched to the movement of the theater so that a leisurely and informative tour around pulsating protoplasm at times becomes a white-knuckle encounter with the life forces that rage within

the human body. Also on display at the Life and Health Pavilion will be a novel mechanical theater called “Cranium Command,” featuring a new “Audio-Animatronics” figure named Captain Cortex, who dramatizes the functions of the brain. Other attractions include “Frontiers of Health,” exhibits highlighting the leading edge of health, “Fun House of the Five Senses,” sensory stimulation for children, and “Lifestyle Terminals,” where Disney guests can analyze their personal health habits. “The Anatomical Players,” a theater troupe,

Passengers descend into the human body’s circulatory system aboard “Body Wars,” opening in ‘89 at Walt Disney World.

will involve patrons in humorous skits. In “Goofy About Health,” a multi-screen video presentation, the famed Disney character comes to terms with good health habits. At the “Sports Fitness Area” guests become physically involved in electronically enhanced exercises. Life and Health Pavilion will combine excitement, and positive health information for the millions of visitors who travel to Walt Disney World each year.

Editor: Tim Cole
Contributors: Jennifer Gosselin,
Nick Nichols, Chris Davis,
Josh Eppinger, Mike Fillon,
William Siuru, David Lampe

TECH UPDATE

DECEMBER 1987

Solar-Powered Racers

DARWIN, AUSTRALIA

—Twenty sunmobiles from six nations sprinted off the starting line November 1 in the World Solar Challenge Race. The event pitted various sun-powered vehicle concepts in a marathon from Darwin to Adelaide, Australia. Although several people mounted individual efforts, the General Motors Sunracer offered an intriguing

GM PHOTO



The General Motors Sunracer with gold-tinted windscreen.

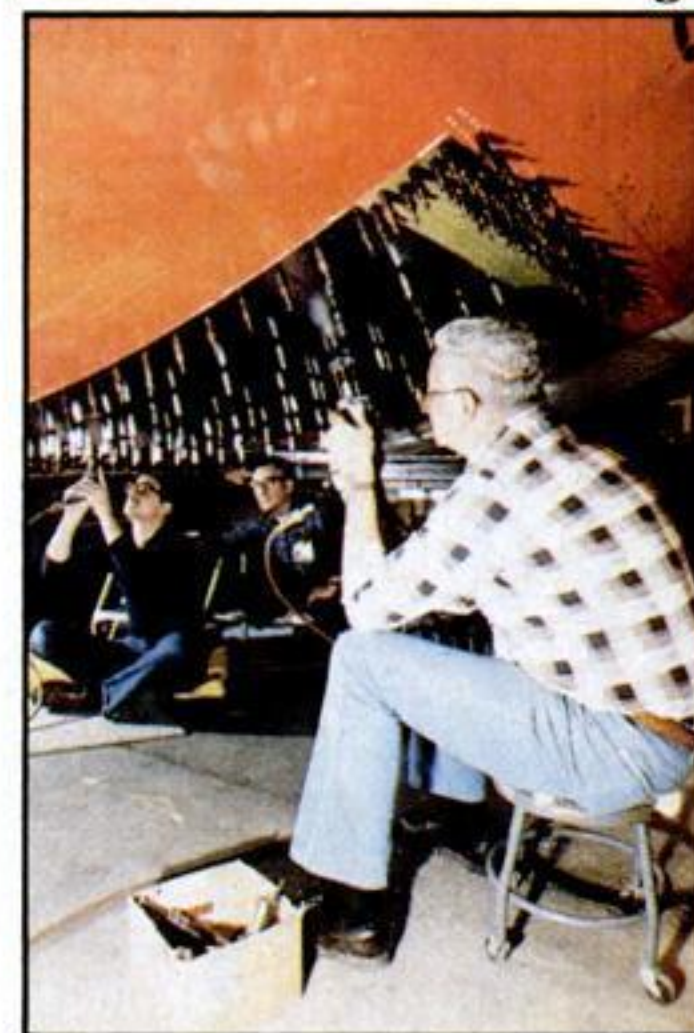
preview of the technologies emerging in solar-powered vehicles—some capable of 60 mph speeds.

With a curb weight of 360 pounds, the 20-ft.-long aerocar carries 60 pounds of sophisticated silver-zinc batteries and 7200 individual

solar cells. GM engineers claim they've created the most aerodynamically efficient vehicle ever, breaking drag-reduction records at a Cal Tech wind tunnel. GM says Sunracer will help test tomorrow's lightweight, high-strength auto parts.

Thermoplastic Fuselage Panel

MARIETTA, GA—The aircraft belly skin is being fitted on a C-130 by Lockheed Georgia engineers. They think the thermoplastic sheet will be able to better absorb rocks, sticks and other abuse from hard landings



LOCKHEED-GEORGIA PHOTO

Fitting thermoplastic on C-130.

on unimproved airstrips. Thermoplastics also resist corrosion more effectively than metal aircraft skins. The panels are paving the way for the plastic airplanes of tomorrow.

New Thermocouple

WASHINGTON, D.C.

—The tiny device being developed by the National Bureau of Standards may lead to more efficient, longer-lasting diesel engines. Thermocouples produce a current when heated and are often used in temperature measurement. It can be placed on valves, cylinder heads and other high-wear areas. Temperature input from these spots help control fuel-air mix and timing.



NBS PHOTO

NBS mini temperature sensor.

Robots For Hazardous Duty

SANDIA PHOTO



Sandia's intelligent robot.

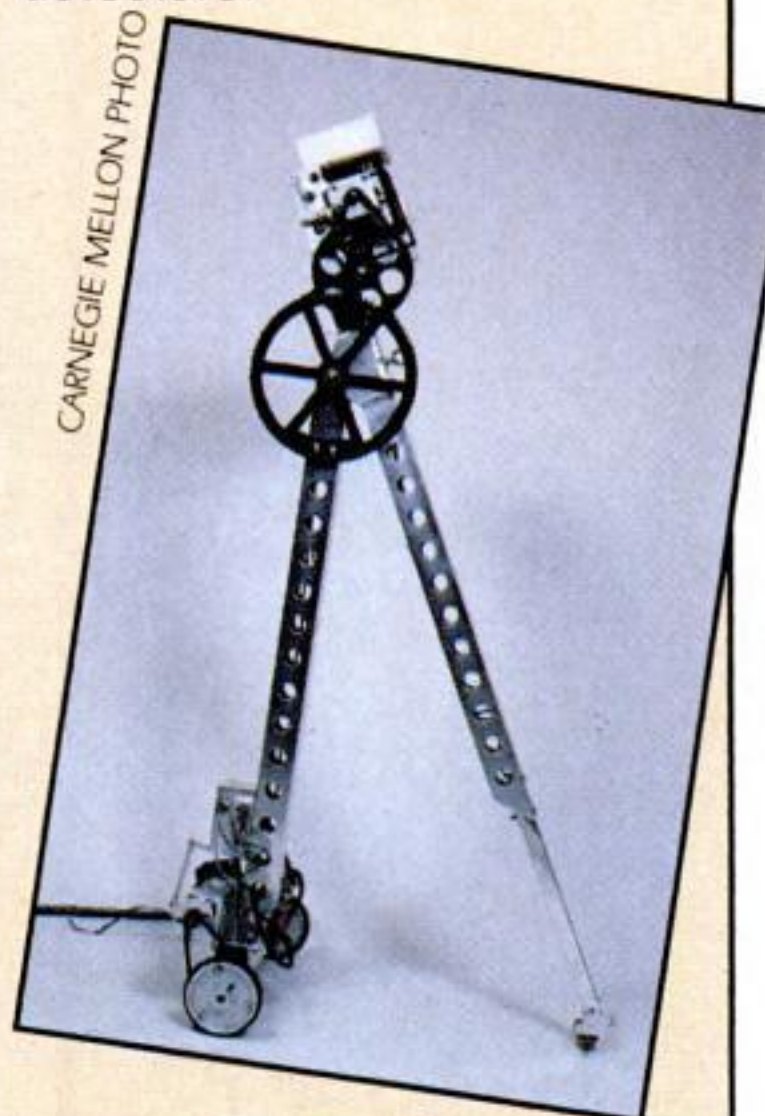
NEW YORK, NY—Machines are beginning to travel where man fears to tread. A new class of programmable robots are being used to perform highly dangerous jobs that were once considered foolhardy, if not impossible. Robots can now sense intruders, handle high-voltage power

lines—even dispose of radioactive waste. At Sandia National Laboratories, autonomous sentry robots are the next generation in robot security. Engineers have developed a robot that doesn't need a preprogrammed pathway or floor wiring to find its way. The Sandia Interior Robot (SIR) can run in either manual mode by a remote operator—or run autonomously through the use of Sandia-developed navigation algorithms. In the autonomous mode, the robot can make path-planning and obstacle-avoidance decisions with the help of sensors.

At Three Mile Island, engineers are using a 6-wheeled robot called Rover 1 to decontaminate the basement of reactor building No. 2, site of a near-meltdown in 1979. The

device has a vacuum attachment to remove radioactive sediment from the basement floor. Rover 1 is equipped with three TV cameras and two radiation detectors.

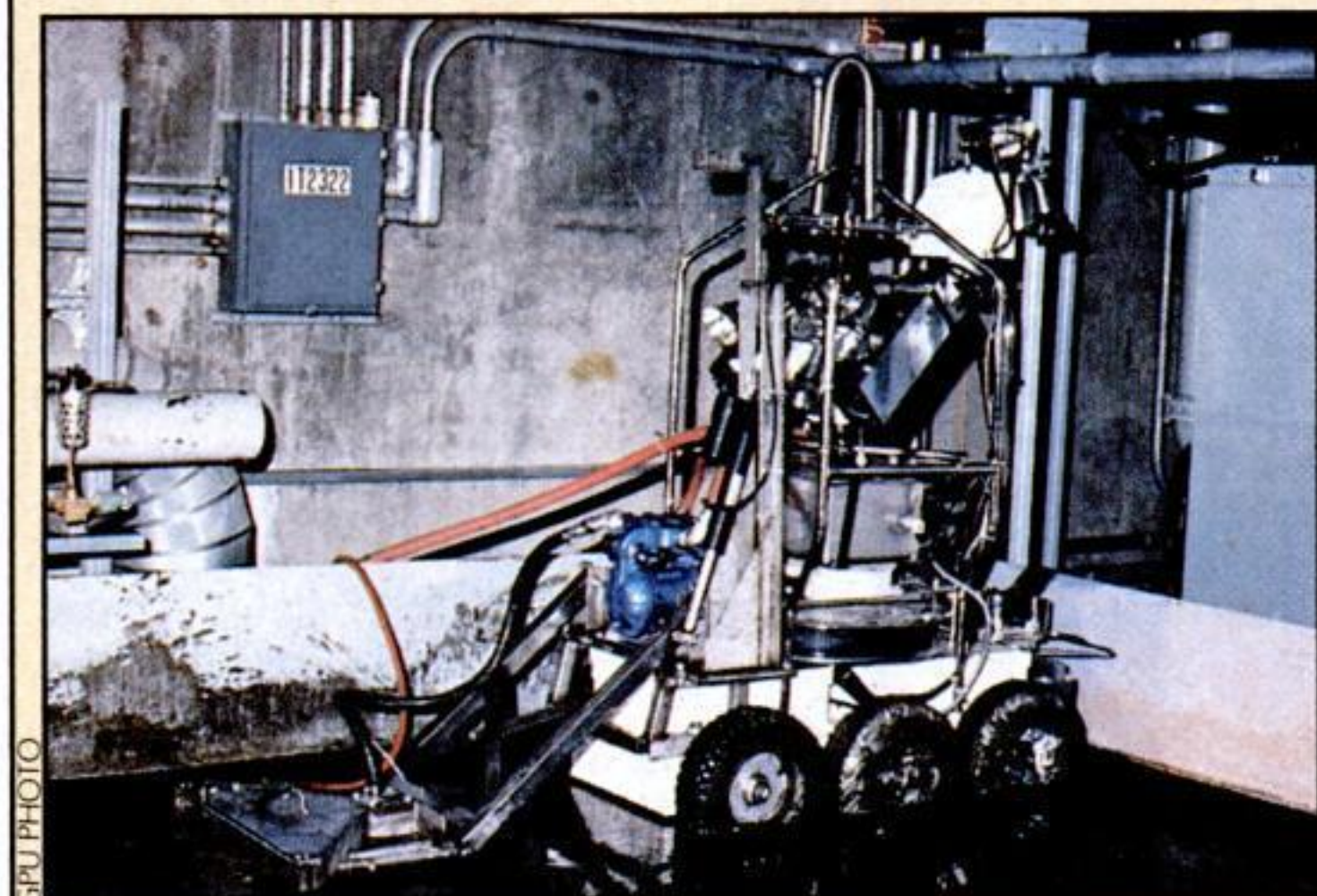
CARNEGIE MELLON PHOTO



A robot for tight spaces.

Nuclear plant officials also have high hopes for a new class of hazardous-duty robots that can work in tight spaces. Graduate students at Carnegie Mellon University have constructed a 2-wheeled, 6-ft. robot that adjusts its posture 25 times a second to reach high places in cramped quarters. The stick-like robot could be used in dangerous environments to open valves, inspect pipes or weld fixtures.

Difficult jobs will never go away. But more machines are being developed that can take over when the going gets tough.



GM PHOTO

Rover 1 on the job at Three Mile Island.

Cutting Tool Of Tomorrow

DALLAS, TX—The high-powered robotic water jet is used to slice and trim aluminum, titanium and resin-impregnated fiber composites. Blasting a water/abrasive substance at up to three times the speed of sound, it's being introduced at LTV Corp. to fashion highly contoured aircraft parts, including honeycomb stiffened panels. The 55,000-psi cutter can penetrate composites up to 4 in. thick and aluminum up to 6 in. thick. Look for water power to continue replacing thermal and mechanical cutting on the nation's shop-floors.

U.S. ARMY PHOTO/LARRY SHANK



An 8-in. mobile howitzer poised beneath the Army's EMP simulator.

Simulated Electromagnetic Pulse

WOODBIDGE, VA—The phenomenon is a byproduct of nuclear detonation and lasts only a millionth of a second. But the result can be catastrophic for electronic equipment. Electromagnetic pulse (EMP) produces intense currents in antennas and cables, burning out sensitive circuitry. Army scientists at the Electromagnetic Effects Survivability Laboratory are using an EMP simulator to address the problem. Charged by a high-

voltage electrical pulse generator, an antenna radiates a strong electromagnetic field. Equipment exposed to the field is then analyzed. One test measures the EMP-resistance of a communications system aboard a tracked 8-in. howitzer. By bombarding equipment with EMP, Army researchers can devise a means of hardening electronics against high-altitude nuclear blast, which can affect electronic systems across an entire continent.

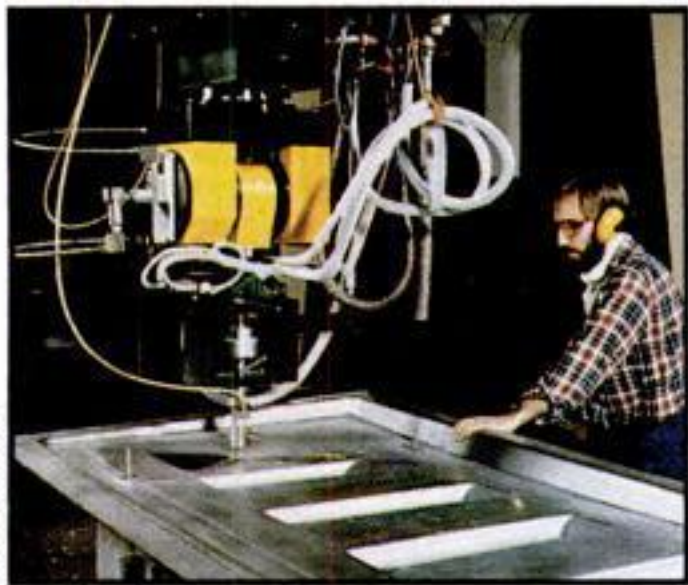
Microwave Storm Detector

LOS ANGELES, CA—The sensor made by Hughes Aircraft Co. went into space aboard an Air Force weather satellite. Microwave energy bounces off a reflector at the top, then funnels into an electronics module where it is processed. The device shows the intensity of the storm and gives ground controllers earlier warnings.



HUGHES AIRCRAFT CO. PHOTO

Sat-borne microwave sensor.



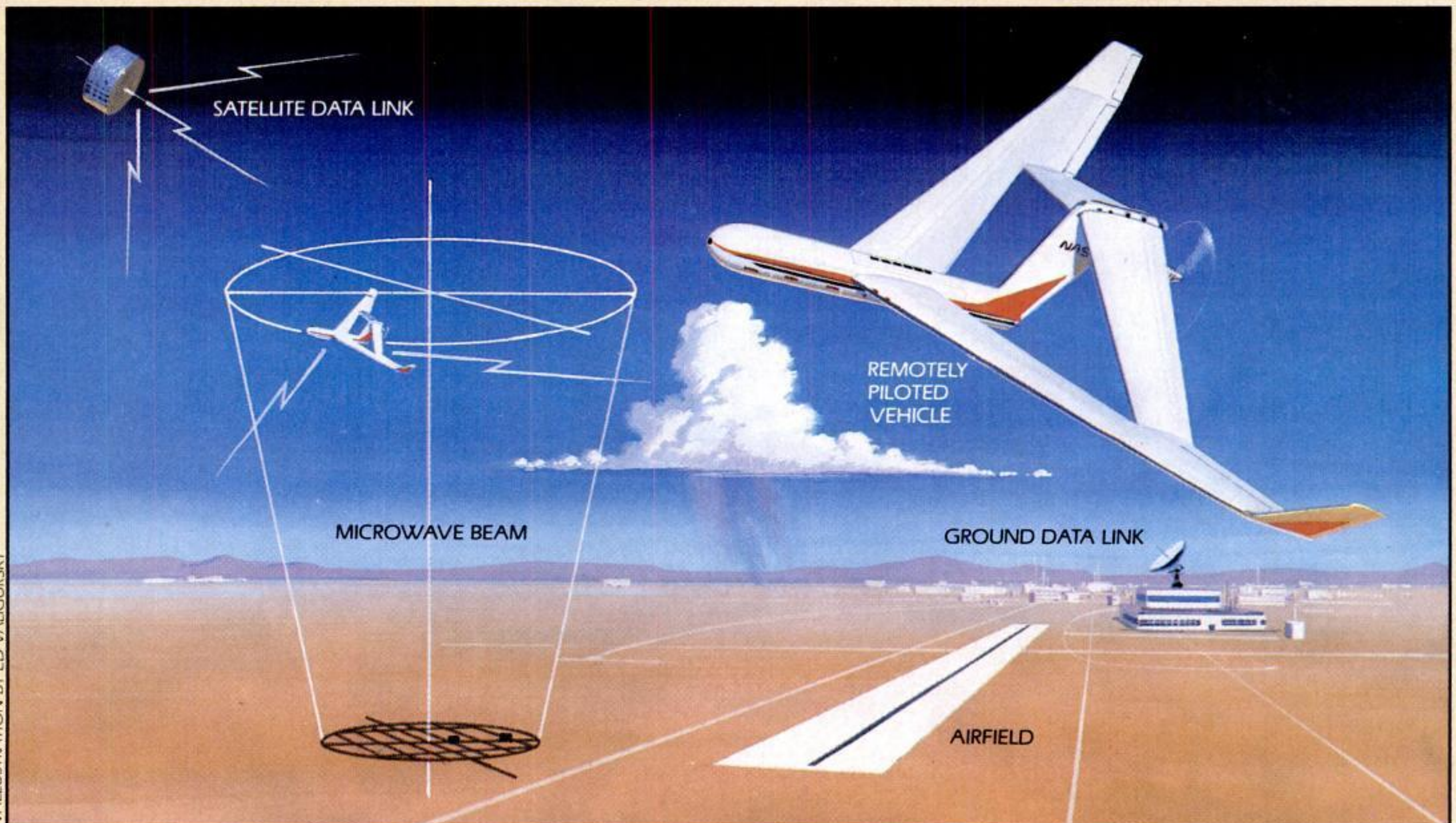
LTV PHOTO

A water-jet cutting machine.

Microwave-Powered Airplane

HUNTSVILLE, AL—The long-duration, remotely piloted aircraft may one day monitor carbon dioxide concentrations in high Earth atmosphere. Named COOPS (Carbon Dioxide Observation Platform System), the plane could stay aloft for 60 to 90 days and might also serve as a coastal marine patrol, fire communications relay station, or remote sensing plat-

form. Scientists at NASA's Marshall Space Flight Center say COOPS could be powered by microwave transmissions from the ground. The energy would be picked up by receiving antennas on the underside of COOPS wings. Roughly 30 kilowatts of electricity would power a motor that would drive a single propeller. NASA planners say the arrangement would be cheaper and more effective than a satellite.



COOPS captures microwave energy from ground antenna, then sends data to surface stations.



Heads-Up In The Cockpit

SAN FRANCISCO, CA
—Fighter pilots have long enjoyed the advantages of seeing their instruments displayed at eye level on the windshield. Soon, the benefits of heads-up displays (HUDs) may cross over to the world of commercial air travel following tests by engineers at NASA's Ames Research Center. HUD-equipped simulators are currently evaluating pilot reaction and response using HUDs. Identical simulators without HUDs provide a baseline. Other airplane cockpit developments include new holographic flight panels currently being evalu-

ated by pilots. Laser-based holographic images are being projected on light-sensitive screens at GEC Avionics in Rochester, England. The wide-angle-raster heads-up displays use diffractive holographic optics to give pilots extreme wide-angle views of engine instruments during combat, day or night. The development is the next logical step on the road to the "God's Eye" laser projection cockpit of the future.



(Right) Heads-up displays in the commercial cockpit. Holographic heads-up images (below).



(Top right) Prototype Navy Airship. (Above) Airship's gondola: three decks include sleeping quarters for long-duration flight.

Return Of The Airship

WASHINGTON, D.C.

—The U.S. Navy has awarded a contract to Westinghouse-Airship Industries to build a prototype blimp that would warn ships of impending enemy attack. The huge helium-filled craft could remain aloft for days and sense threats more than 130 miles over the horizon. Early models show a 3-deck gondola with spaces for pilot/copilot, electronic systems

officers and sleeping/living areas. The prototype ship will reportedly carry an electronics suite identical to the Grumman E-2C Hawkeye, the Navy's current eye in the sky. But Navy planners say the dirigible will be able to carry a larger radar aperture and possibly a phased-array radar system, which would pick up smaller, faster targets—like surface-skimming Exocet antiship missiles.



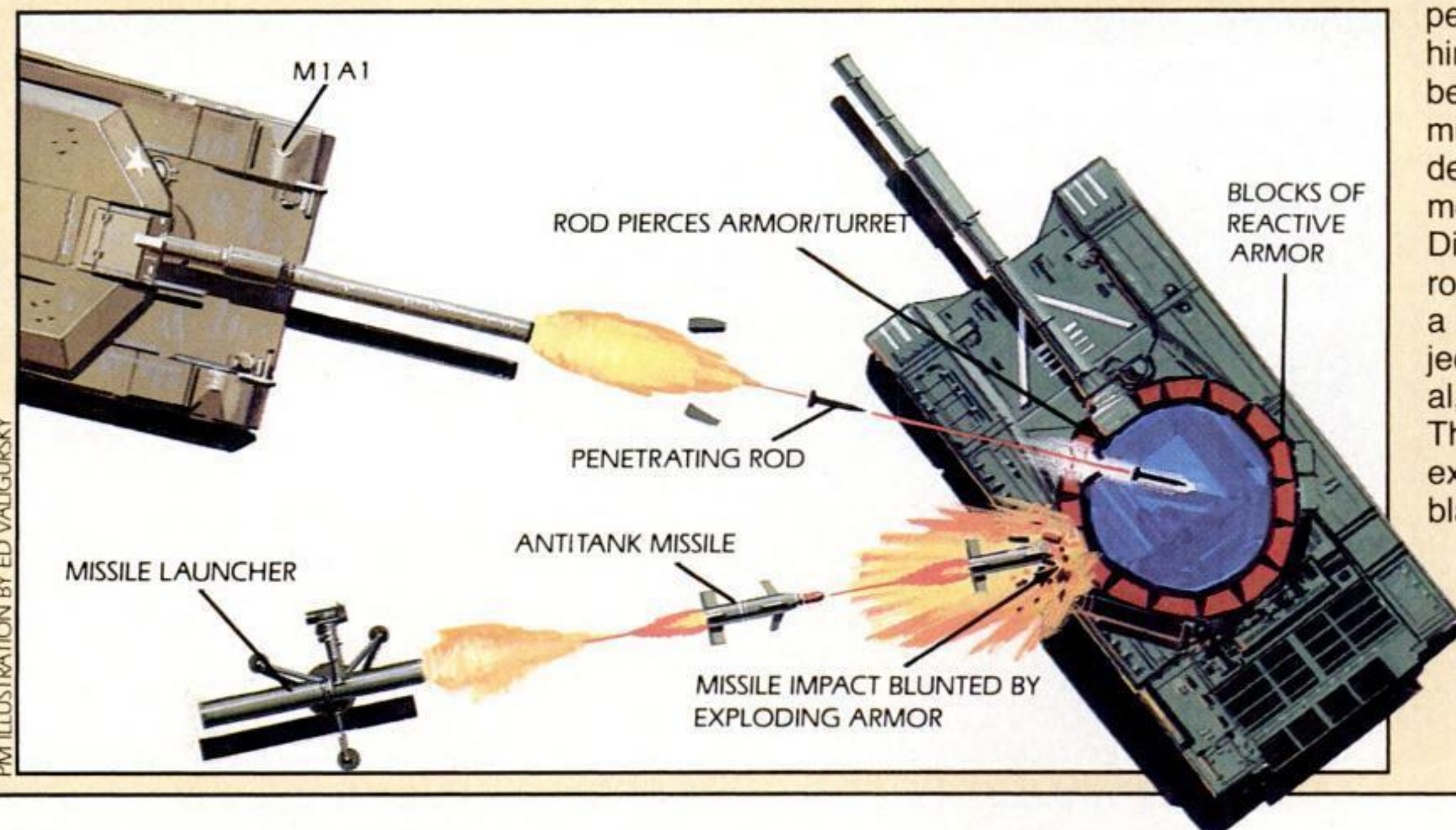
Reacting To Reactive Armor

NEW YORK, NY—The system is drastic yet effective. Thousands of Soviet tank hulls and turrets are being lined with bricks of explosive.

Speculation has it that the explosives in each box are arrayed in a venetian blind-like pattern. When High-Explosive, Anti-Tank (HEAT)

rounds strike the bricks, the resulting explosion counteracts and dissipates the force of impact. This so-called "reactive armor" has made a generation of antitank weapons obsolete, posing a signifi-

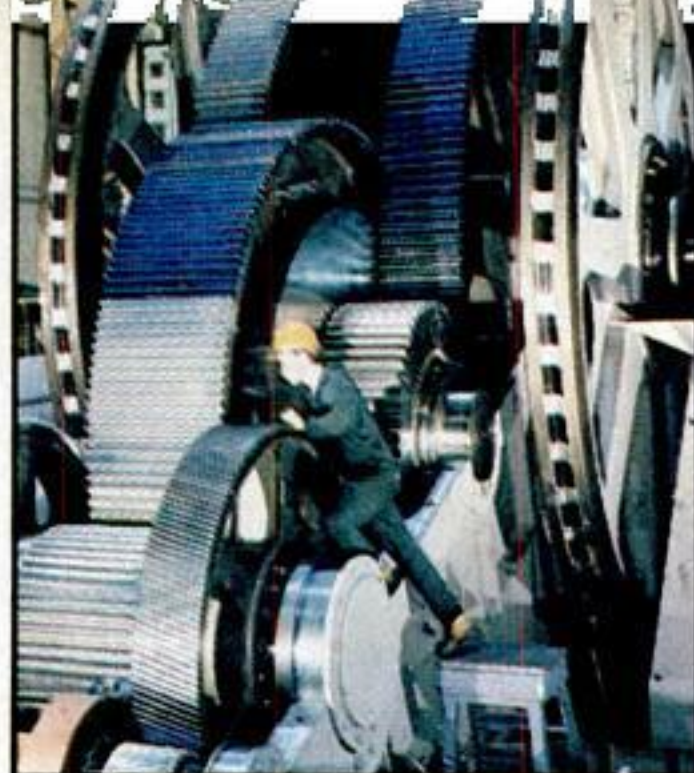
cant threat to NATO's front-line forces. The Army is working on a new kind of TOW missile with a predetonator that explodes the reactive armor on impact, clearing the way for a more powerful penetrating round right behind it. Another solution may be new kinetic-energy ammunition that is currently in development. Called an Armor Piercing, Fin-Stabilized Discarding Sabot (APFSDS) round, the new cartridge fires a small caliber, dart-like projectile of high-density material, such as depleted uranium. The round's small size and extreme velocity may let it blast through reactive armor and counter the vast fleet of Soviet tanks.



New type of high-velocity antitank round may defeat USSR's "reactive armor."

World's Biggest Gearbox

HUDDERSFIELD, ENGLAND—The gargantuan machine will operate a coal-bearing conveyor at a drift mine in Nova Scotia. Crafted by David Brown Gear Industries, the gearbox will help the conveyor bring coal and stone from underground deposits up a 12° slope at 2200 tons per hour. To maintain a full belt, electronic controls enable the gearbox to run the conveyor at speeds of between 3 and 6 meters per second. The differential alone weighs 25 tons, and the whole gearbox weighs in at a whopping 250 tons. Principal dimensions are 10.5m × 5m

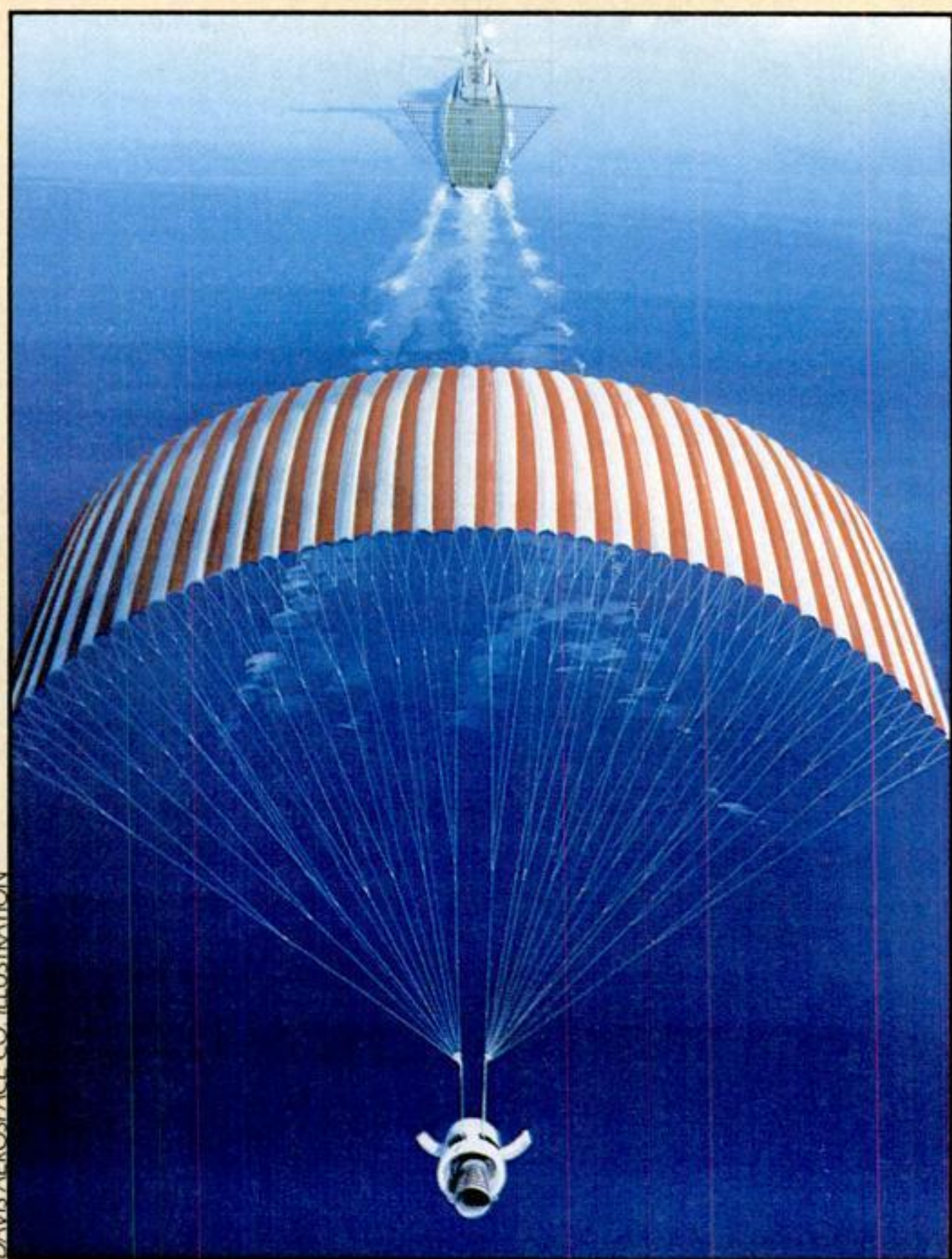


LONDON PICTURES SERVICE PHOTO

Gearing up to power conveyor.

× 6m. The giant final-drive wheel measures 5.6m in diameter. The entire system is powered by twin 6400 kilowatt engines. Lining up the gearbox bores and the shafts required precise engineering. Despite high-tech advances in other fields, big jobs still require big, low-tech machinery.

Space Recovery System



CONSORT liquid-propellant engine is guided to recovery at sea.

GEORGETOWN, TX—CONSORT is the latest private enterprise proposal to provide launch services to NASA—with a difference. Conceived by the Davis Aerospace Co., CONSORT integrates a heavy lift booster with a plan to recover the vehicle's primary liquid propellant engines. Each of four outboard engines would be jettisoned, leaving a single centerline thrust engine to push the payload into orbit. The engines would descend through the atmosphere and deploy radio-controlled ram-air parachutes. The engines would then be guided to ships equipped with arresting gear. After the CONSORT achieves orbit, planners say, it could be refueled in space, making it an orbital transfer vehicle.

Total In-Flight Simulator

BUFFALO, NY —The heavily modified C-131 transport is helping test fly-by-wire technology in advanced commercial aircraft. The dual-cockpit plane, operated by the Arvin/Calspan Advanced Technology Cen-

ter, has a test cockpit grafted to its nose. Computerized flight controls and special auxiliary control surfaces let the plane duplicate the flight characteristics of any aircraft. Current testing is centered on the Boeing 7J7.

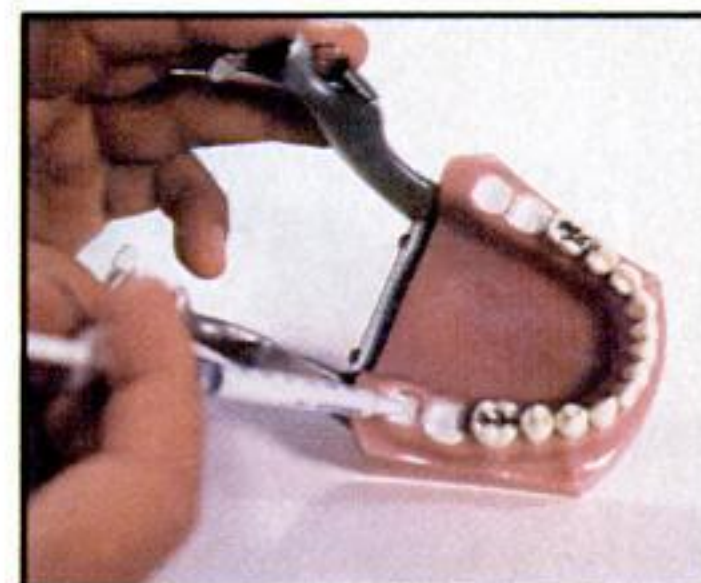


USAF PHOTO

The dual-cockpit aircraft can simulate virtually any airplane.

Futuristic Fillings

"Bone cement" is how Dr. Laurence Chow, chief research scientist at the American Dental Assn., describes the calcium-phosphate compound he has developed. "When fully dried," he says, "it has a chemical composition identical to bone mineral—as in teeth." What better material to replace those used in root canal work now?



NBS PHOTO

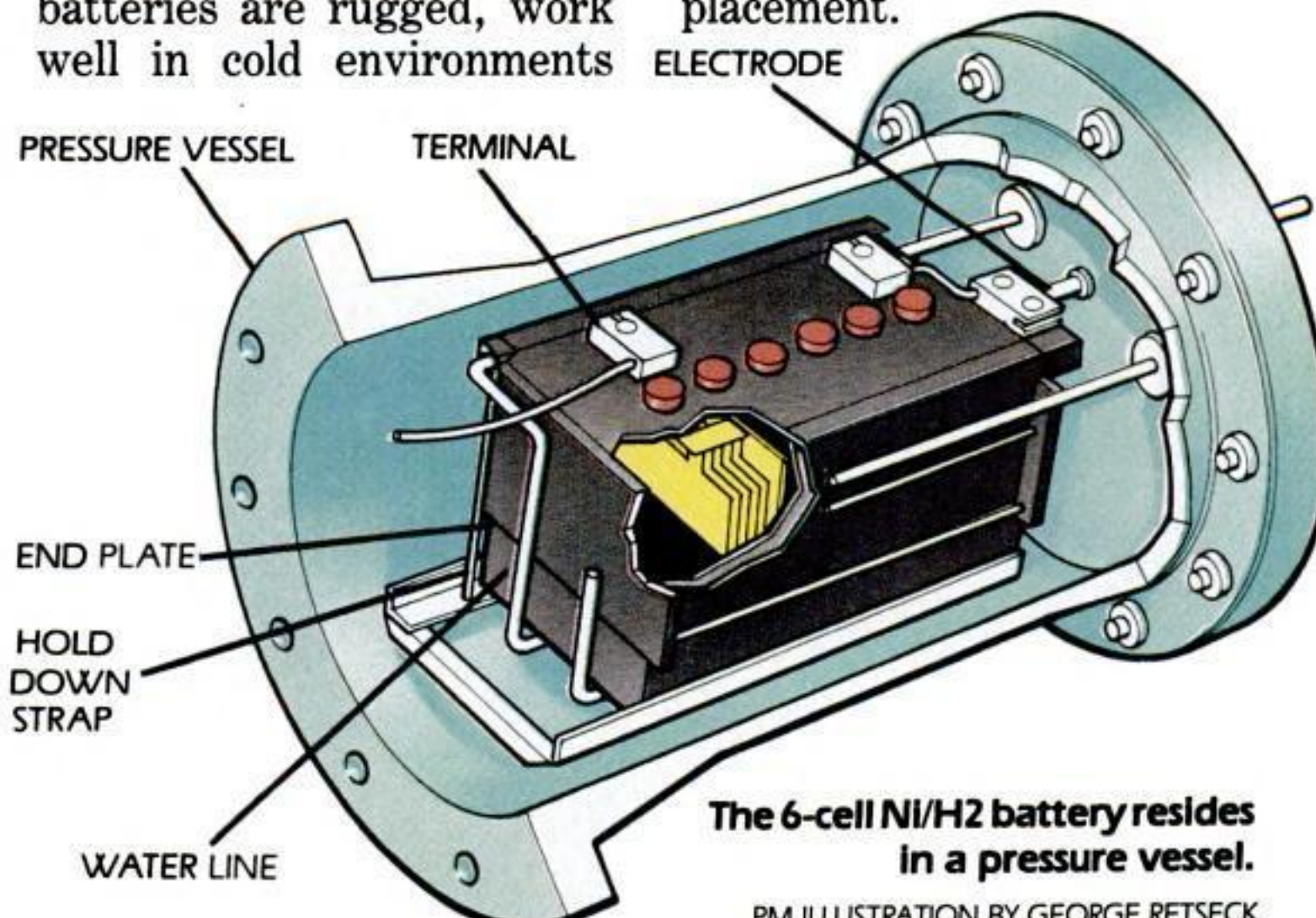
Teeth of tomorrow?

"The body doesn't consider it foreign," says Dr. Chow, "so it doesn't reject it." It must meet FDA approval.

Down-To-Earth Space Battery

ALBUQUERQUE, NM —Originally developed for satellites, the nickel/hydrogen power cell may soon find an application as a power source in remote regions. Engineers at Sandia National Laboratory say the space batteries are rugged, work well in cold environments

and can withstand numerous charge/discharge cycles. Work is focused on making the battery work with solar arrays. Most solar systems use lead/acid batteries, which require periodic maintenance and frequent replacement.



The 6-cell Ni/H₂ battery resides in a pressure vessel.

PM ILLUSTRATION BY GEORGE RETSECK

The fact that the 1988 LTD Crown Victoria's looks have changed lets you know that Ford hasn't stopped improving on this traditional favorite. But rest assured, these improvements have done nothing but enhance what you've come to expect...and respect in this luxurious sedan. Over the years, we've improved its renowned smooth ride, heightened its engine performance and added finishing touches to its richly appointed interior, as well as its spacious, deep-well trunk. In short, we've given you the room, ride and comfort you desire in an uncompromised full-size car. What we've done for 1988, is what we've done throughout the years—refine the design and enhance the engineering to make this LTD Crown Victoria that much better than its predecessors.

6-Year/60,000-Mile Powertrain Warranty.

Covers major powertrain components for 6 years/60,000 miles. Restrictions and

deductible apply. Also, participating dealers back their customer-paid work with a free Lifetime Service Guarantee, good for as long as you own your vehicle. Ask to see these limited warranties when you visit your Ford Dealer.

Ford. Best-built American cars...seven years running.

Based on an average of owner-reported problems in a series of surveys of '81-'87 models designed and built in North America. At Ford, "Quality is Job 1."

Buy or lease an LTD Crown Victoria at your Ford Dealer.

Ford LTD Crown Victoria.

Ride and comfort remain a big idea in the 1988 LTD Crown Victoria.

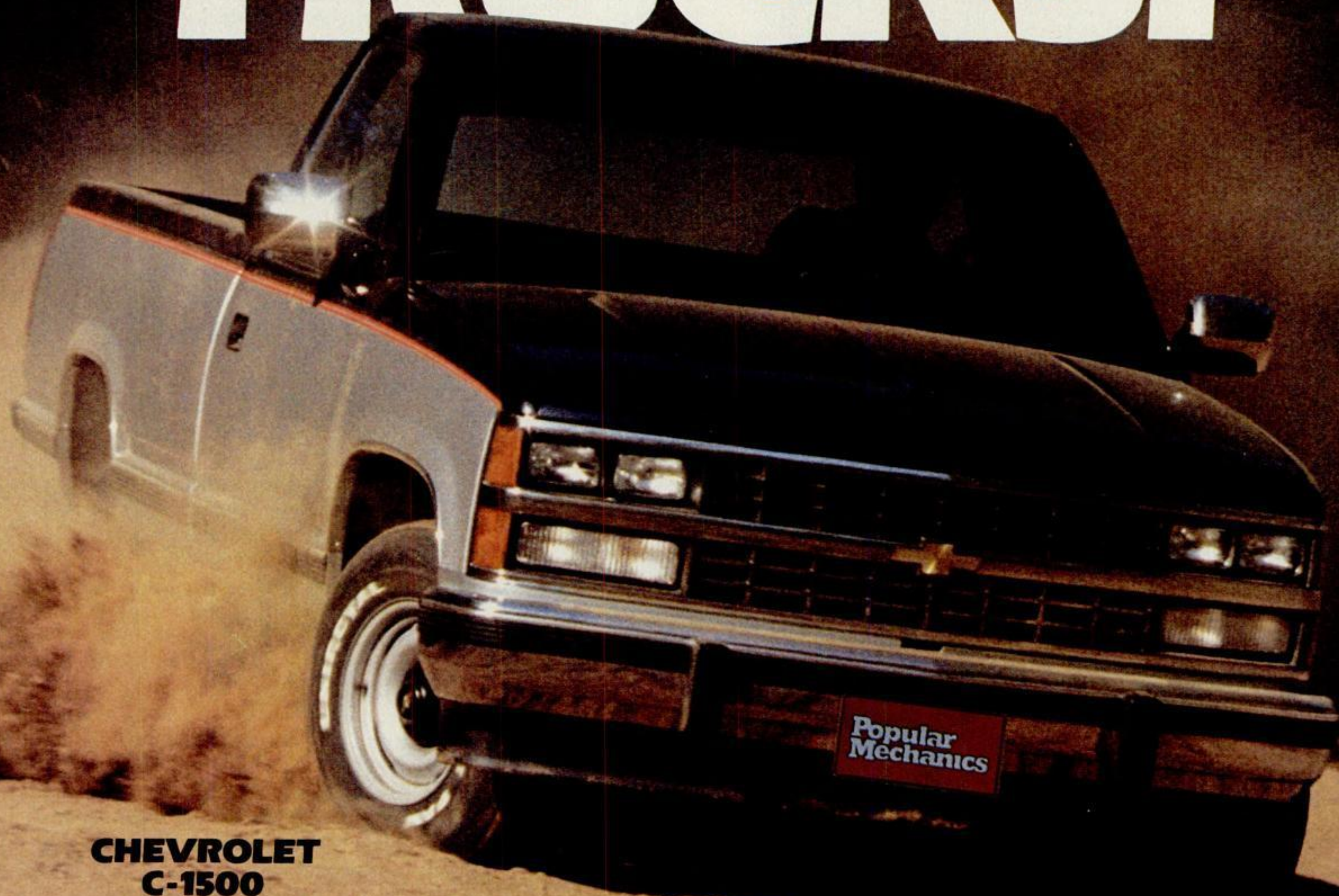


Buckle up—together we can save lives.

Have you driven a Ford...lately?



THUNDER TRUCKS!



**CHEVROLET
C-1500**

How much truck do you want? And how fast do you want it to be?
We check out three full-size, V8-powered, hot-rod pickups.

WE'RE talking serious trucks here. Full-size V8s, the kind of truck that made America great. None of your pantywaist imports or compacts, just three husky haulers only a few steps removed from Bigfoot. There are only a few of them left, but aside from the Jeep J-10, none is close to being an endangered species. In fact, Ford and Chevy have just re-engineered their biggest pickups while Chrysler, as usual, is remaining competitive through a clever market-

ing ploy. We decided to test these three brawny V8s and compare them with their closest competitors—the new midsize Sixes from Dodge and Jeep—to see how they stacked up in performance and practicality.

There are lots of reasons to buy a pickup truck, and the Big Three cater to them all, from big-block hot rods to crew-cab workhorses, you can build almost any kind of truck you want from the dealer's order book. You want dual rear wheels, extended cabs, 4-wheel

THUNDER TRUCKS!



DODGE D-100



"Old-fashioned" best sums up the Dodge approach to truck design, but that's not all bad: Styling may be dated, but service, controls and price bring back the good old days.

drive, bucket seats, light bars, outrageous engines or axle ratios? Just check the boxes you need in the Chevy or Ford order form. The Dodge catalog is more limited, but it covers all the basics and then some.

To make things equal, we decided to pick something all three companies offered—small-block, short-bed, hot-rod trucks. Ignoring the huge 7½-liter V8s (Chevy's 454 and Ford's 460), which are available only on hulking 1-ton models, we settled on 5.7 liters, since the three companies are very evenly matched here (Chevy's is 350 cu. in., Ford's 351 and Dodge's 360).

But our plans began to unravel a bit:

Chevy had a bright, new 350 5-speed in its press fleet, but it had the long 8-ft. bed. Ford was able to build exactly the truck we wanted, with 1988's newly fuel-injected 351 V8. But Chrysler couldn't come up with a 360 V8, and strongly recommended that we try its low-ball special—the Dodge Ram D-100 with its 318 V8, the trucking world's equivalent of Omni America—\$8089 at the time of our test.

So we took what we could get and trucked on down to our usual test venue at Raceway Park in Englishtown, New Jersey. We started by checking out their performance both loaded (with 1000 pounds of railroad ties) and empty.

We also did our usual subjective evaluation, this time around a long loop of local roads that included every sort of surface, from freeway to dirt.

Seven drivers rated each truck, and we averaged their scores for our results. Our spec charts show the bed sizes available on each truck, in addition to the ones we tested.

Designing a pickup truck is a handful of compromises. Empty, the weight distribution is substantially forward. Suspension and, most especially, brakes must be calibrated to match. This means biasing the brakes so that the front wheels do most of the work, otherwise the rear wheels will lock early, causing loss of control. The rear spring rates need to be stiff enough to hold up the heaviest rated load—and that makes the brake problem worse when you're empty. This also applies to handling.

The major penalty for too much rear spring and too much front brake is slightly longer stopping distances. Too little of either invites unstable, back-end-first stops. Besides, trucks do spend most of their time being driven empty, so all-in-all, setting things up to favor that mode is best.

We realized that trucks have traditionally been tested by magazines as if they were cars. They've been run down the same dragstrips and over the same skidpads, and always with the bed empty. A test of how well a truck performed at both ends of the center-of-gravity limits has been long overdue.

This sounded like a good idea in the office, until the PM auto department staff spent an afternoon in 90° heat slogging 10-ft. 6x6s, 1000 pounds of them, from one truck to another for the performance section of this test. Or until the lumber shifted and trashed the bed and back of the cab on the Chevy. Oops.

To no one's surprise, trucks are slower carrying a load. But not as slow as we expected, and some dealt with the weight better than others.

Ford F-150

Compact and mini-pickups have been knocking the socks off the big boys in the truck market for the past few years, and Ford was the first to do something about it when it introduced a new full-size truck in 1987. On the outside was a fresh new aero facelift, which still managed to look macho. New grille, fenders, hood, wraparound parking lights and flush, impact-resistant headlights did the trick.

Under the re-skin are retuned suspensions and an antilock brake system (ABS) for the rear wheels that solve those old empty pickup spinout blues. Where conventional pickups make skitterish stops (especially on dirt or wet pavement), the ABS stops 'em straight and true.



FORD F-150

Engines have been switched one at a time from cranky carburetors to fuel injection—first the 4.9-liter Six, then the 5-liter V8 and finally, for 1988, the 5.8-liter V8 fitted to our test truck. It developed a healthy 210 hp and sounded like a NASCAR stocker.

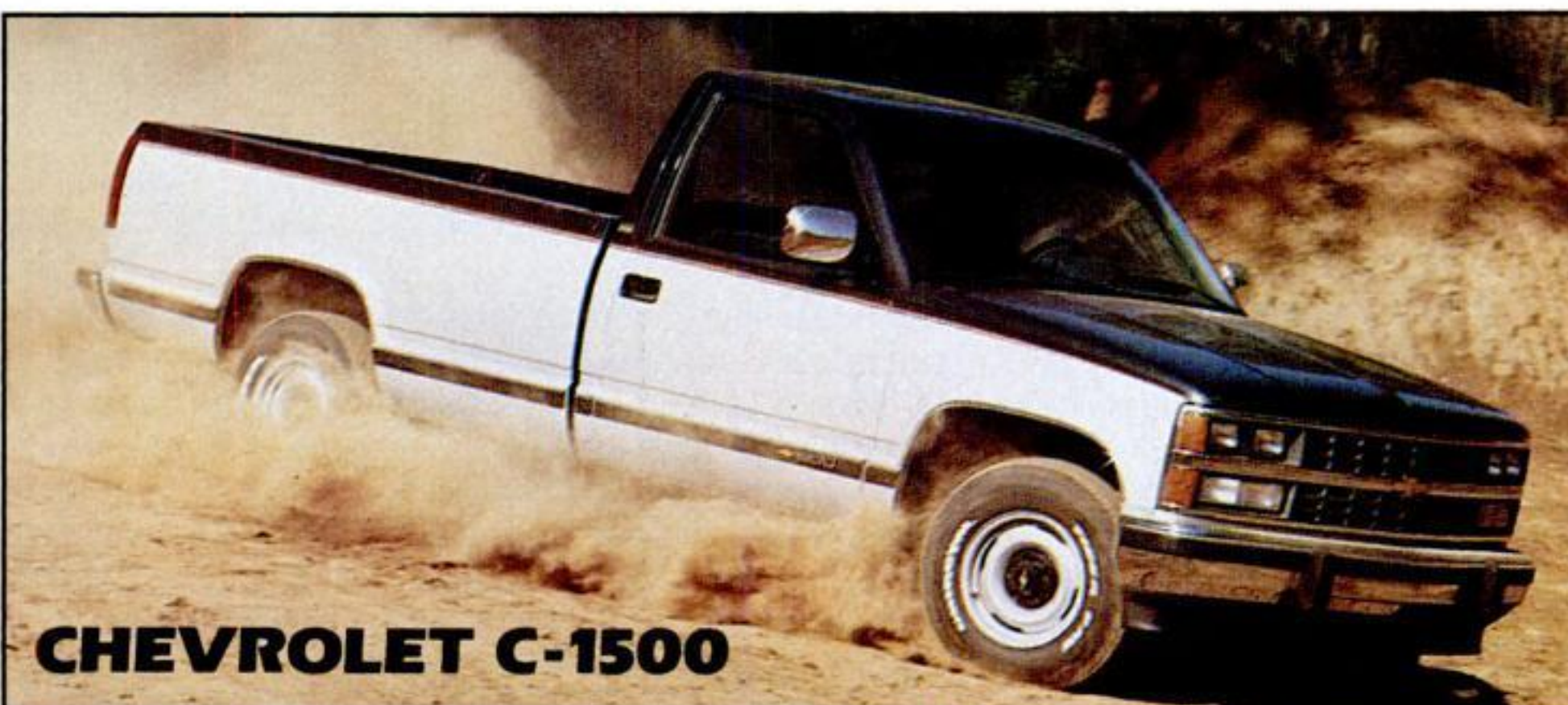
Mated to a crisp-shifting 4-speed automatic, our sinister black F-150 snapped off ¼-mile times that were a good 1 to 1½ seconds better than the competition, loaded or empty. And the Ford blew the other trucks away in just about every other performance test, too, finishing first on the track.

There's a reason why Ford has been first in truck sales for the past 17 years, and our road testers' reaction to the F-150 showed why. Although all three big trucks in our test were equipped with fairly primitive bench seats (with no provision for adjusting the angle of the seatback), the Ford's was judged far and away the best. Despite a few quibbles from one or two testers, the Ford bench was praised for its comfort, support and choice of fabric covering. The whole interior layout of the Ford is practical, functional and attractive without being overly styled or cutesie.

Handling got mixed reviews, some testers feeling that the combination of a short wheelbase, stiff springs and lots of power made the Ford a handful, especially in the rain. The ABS brakes were also a bit weird. Although the rear wheels didn't lock up, our test truck did pull to the left and dip toward the right in heavy braking, so that the cab seemed to be screwing itself into the ground. Obviously, one brake was



Ford had the best performance and most habitable interior of the group. Newly fuel-injected 5.8-liter V8 pumps out an impressive 210 hp with its port fuel-injection system.



CHEVROLET C-1500



All-new Chevy combines good looks and performance with throttle-body fuel injection on its 5.7-liter V8. Interior is long on style, short on comfort and practicality.

THUNDER TRUCKS!

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/MODEL	BASE PRICE	PRICE AS TESTED	ENGINE	TRANSMISSION	WHEEL-BASE (in.)	LENGTH (in.)	WEIGHT (lb.)	AVAILABLE PAYLOAD CAPACITY (lb.)	CARGO BED DIMENSIONS ¹	AVAILABLE LENGTHS (ft.)
Chevrolet C-1500	\$9531	\$15,573	210-hp OHV 5.7-liter V-8	5-speed manual	131.5	212.9	3756	1539-5197	62.25/49.5/97.5	6½, 8†
Dodge Ram D-100	8089	11,209	135-hp OHV 5.2-liter V-8	3-speed automatic	115.0	195.0	3700	2320-4450	66.0/51.0/78.25	6½†, 8
Ford F-150	10,272	15,000*	210-hp OHV 5.8-liter V-8	4-speed automatic	116.8	194.1	3650	1300-5450	65.0/50.75/82.0	6½, 6¾†, 8

*Estimate; †Nominal bed length of test truck

1. Interior width/width between wheel housings/length.

2. Best speed while weaving through seven cones placed 100 ft. apart. The higher the speed, the better the transient handling.

3. G-forces generated during steady-state cornering around a 200-ft.-dia. circle; cw=clockwise, ccw=counterclockwise.

working a lot worse than the others—something we hope was confined to this one truck and would be easy to adjust. Laden with lumber, there was definite notice from the suspension of the extra weight, but not obtrusively so—just enough to remind you not to try anything vigorous until you've jettisoned the external stores.

The Ford did have the smallest interior of our three big trucks, but otherwise there was little to fault as far as making the driver happy was concerned. Testers' comments ranged from "solid," and "serious" to "a real truck," and that was meant as a compliment. Specific likes included the powerful 5.7-liter V8,

real vent windows and general comfort. Dislikes centered around trivia like fake wood trim on the dash to a real concern about the handling, which our most optimistic tester called "challenging, but fun, like an overpowered hot rod." Five out of seven testers voted it into first place on the road. Combined with its first on the test track, this registered a clean sweep.

Chevrolet C-1500

Bob Berger, general manager of the Chevrolet division, claims that the 1988 full-size Chevy pickups are "all-new, with only about a dozen carryover parts from previous models." If you count en-

gines, axles and other major assemblies as "one part," Bob's right.

Suffice to say that the '88 Chevy is a significantly new truck, with every major component redesigned or at least re-examined. Highlights include fuel injection on all available engines, a new Muncie-Getrag 5-speed transmission with aluminum case, a new boxed frame, a carbon-graphite driveshaft with aluminum yokes, standard power steering and computer-controlled ABS on the rear brakes to prevent lockup and spinouts with a lightly loaded truck. The body features more glass, flush-mounted, and even a spoiler under the bumper to cut drag by 15 percent.

HOW MUCH TRUCK IS ENOUGH?



DO you really need a full-size, gas-guzzling V8 pickup, or will something handier do? To find out, we took two of the new "midsize" Sixes along: the Dodge Dakota and Jeep Comanche.

The Jeep, with its 173-hp, 4-liter in-line Six, though only 250 pounds lighter than the hot-rod Ford F-150, was just a whisker behind it in performance. Yet actual gas mileage was far and away the best in the group. Our road testers found the Jeep's upscale-bucket seats the most comfortable, even though they did limit the Comanche to a strict 2-seater. With a base price of only \$6495, the Comanche looks like a winner. Where it falls short of the big boys is sheer size and hauling ability. The Jeep bed is only 55¼ in. wide (43½ between the wheelwells) and available in 6- or 7½-ft. lengths. Payloads range from 1200 to 2205 pounds, depending on

options. Our testers praised the Jeep's 5-speed gearbox, slick shifter and readable instruments. Numb steering with no road feel, wobbly handling and a stiff ride were criticized. But five out of seven testers preferred it to the Dodge. Our Dodge Dakota was powered by a 125-hp, 3.9-liter V6 that had only 3215 pounds to move but was by far the slowest on the track. It did have a bit more room, inside and out, than the Jeep with a cargo bed 57½ in. wide (45 in. between the wheelwells) and the choice of 6½- or full 8-ft. lengths. Cargo capacities range from 1250 to 2550 pounds. Base price is \$7529, but our test truck ran the tab up to \$9613, still \$2000 to \$6000 less than the big guys for nearly as much truck. Our road testers found the Dakota down on power and noisy, but felt that the steering and handling were better than the Jeep's.

MANUFACTURER/MODEL	GAS MILEAGE (EPA city/PM test)	ACCELERATION ¼-MILE UNLOADED/LOADED SECONDS @ MPH	ACCELERATION 0-60 mph UNLOADED/LOADED (sec.)	BRAKING (ft.) (60-0 mph) UNLOADED/LOADED	700-ft. SLALOM UNLOADED/LOADED (mph)	200-ft. SKIDPAD (cw/ccw) UNLOADED (LOADED)	INTERIOR SPACE INDEX
DODGE DAKOTA	18/15.67	18.121 @ 74.62/20.123 @ 68.23	11.28/16.41	140/197	52.76/48.11	.68/.71 (.65/.67)	77.73
JEEP COMANCHE	17/17.80	16.577 @ 82.41/18.471 @ 74.93	9.13/10.86	145/204	55.46/50.51	.73/.74 (.71/.72)	70.63

TEST RESULTS

GAS MILEAGE (EPA city/ PM test)	1/4-MILE UNLOADED/LOADED (sec. @ mph)	0-60 mph UNLOADED/LOADED (sec.)	BRAKING (ft.) (60-0 mph) UNLOADED/LOADED	700-ft. SLALOM ² UNLOADED/LOADED (mph)	200-ft. SKIDPAD ³ (cw/ccw) UNLOADED/LOADED	INTERIOR SPACE INDEX ⁴	TEST TRACK RANKING ⁵	ROAD TEST RANKING ⁶	OVERALL RATING ⁷
16/11.12	17.460 @ 77.98/ 18.435 @ 74.19	9.69/11.19	164/210	54.35/49.55	.71/.71 (.67/.67)	90.63	2	2	2
16/12.48	17.780 @ 75.06/ 19.426 @ 70.20	10.09/12.37	131/184	51.23/45.56	.66/.69 (.61/.69)	86.11	3	3	3
16/11.86	16.434 @ 80.78/ 17.682 @ 75.37	8.95/10.97	150/182	51.43/49.81	.73/.75 (.68/.73)	80.17	1	1	1

4. Front-seat width × headroom × legroom ÷ 1000.

5. Points are awarded from best (1) to worst (3) in each category. Fewest total points ranks first, and so on.

6. Subjective ranking on the road by a team of testers. Trucks are graded by "feel," independent of test track results.

7. Average of Test Track and Road Test ratings. Road Test score breaks ties. Bold numbers show best performance.

Chevy calls it "the first high-performance machine that can carry a 4 × 8-ft. sheet of plywood." Bob Berger said, "The suspension is designed to ride and handle the same way, loaded or empty." We can't let a statement like that go by, hence the 1/2 ton of railroad ties that raised eyebrows at the test track.

To be fair, each of these trucks had its own handling characteristics, both laden and empty, and the Chevy's handling deterioration with 1000 pounds of creosote-soaked wood in the back was neither better nor worse than the other two. Certainly the *feel* of the Chevy didn't change much from empty to full. It may not have been quite as impressive versus the stopwatches, but it had more than enough brawn to handle the job with ease. On the other hand, the Chevy's braking performance fell off a bit more than its competitors with a load, recording stopping distances a good 30 ft. longer than either the Ford or the Dodge.

This is not to say that the nearly all-new Chevy is a bad truck. In most areas, it's pretty good. Its interior is roomiest, the handling felt fine on the road, and the shifter, though heavy, was precise. Styling and general performance got good marks from our testers. Overall, Chevy seemed to have spent some of its development money poorly, coming up with a cramped driving position, overly upright seats, and an over-styled dash that's not only out of place in a work truck, but difficult to use.

The designer instruments, with their rotating discs, were difficult or impossible to read under many daylight conditions. Taking its cue from some of GM's worst designed passenger car dashes, this instrument panel has a bad case of buttonitis, with 22 buttons and rocker switches required to run the radio and ventilation system, teamed with silly Japanese-style illuminated graphics. Not only does this needlessly complicate the whole process, one of the rocker switches was already malfunctioning on this nearly new truck, making the radio real loud when you thought you were making it softer.

Several drivers felt that the brake pedal required too much effort for too

little retardation. All in all, two drivers felt the Chevy was the best truck here, yet three rated it last.

It's not that bad, but obvious annoyances like poor seats, instruments and controls do a lot to undermine an otherwise good impression. These are areas that could be corrected fairly quickly and cheaply, but will they? GM's record in this area is not brilliant.

Dodge D-100

That's no misprint. The D-100 is a special price-leader version of the full-size Dodge D-150. Its base price of \$8089 is \$1500 to \$2000 less than the competition. The price as tested for our modestly equipped Dodge, though \$3000 more, was still some \$4000 less than the fully-



Trucks were put through all our track tests with and without 1/2 ton of railroad ties.

loaded Ford and Chevy. While no one would accuse the Dodge of being a great truck (no one voted it first) you can forgive an awful lot on a working truck for four grand.

What you need to forgive is comparatively anemic performance with only 135 hp from the 5.2-liter V8 (38 less than the 4-liter Six in the Jeep, never mind the Ford and Chevy's extra 75 horses). This power shortage is especially noticeable with a full load. As one tester quipped: "I coulda had a 360!"

Everything about the Dodge is low-buck, from the cardboard headliner that's literally screwed onto the roof to the upright "church pew" bench seat. Assembly quality is nothing to scare the Japanese, either. Our test truck had a gap at the top of the driver's door so

large you could see daylight through it! Naturally, it let in wind, rain and dust.

But before we throw this baby out with the bath water, let's look at the plus side. Sure, it's got 1960s styling, but along with that come instruments, controls and a radio that are easy to understand and use. There's also an uncluttered '60s engine compartment where everything is easy to see and service. The cargo box is the most generous in the group. And unloaded, the plain old Dodge stopped some 20 to 30 ft. shorter than all the fancy-pants ABS systems on the Chevy and Ford. It wanted to slew sideways, but it stopped shortest. Loaded, the Ford stopped only 2 ft. shorter.

Remember that the rear-wheels-only ABS on the Ford and Chevy weren't intended to make them stop any faster, just stay pointed forward. At least on dry pavement, Dodge has managed to achieve comparable performance without the added complexity and expense. We're waiting for 4-wheel ABS to hit the light-truck market.

Not only does it have fewer standard features (like ABS), the Dodge offers fewer options for customizing—there's no extended cab, no crew cab, no dual-rear wheels. But if you're not in the market for those configurations anyway, it's hard to beat that price. Sure, it's got noise, harshness, vibration, wobbly handling, mediocre performance and a funky hood ornament that gets turned around in carwashes, but so what. This is a truck, after all. While four of our road testers ranked it last, three felt it deserved second place.

Conclusion

You want a hot rod, go for the Ford. You want a cheap workhorse (especially if someone else has to drive it), spring for the Dodge. For all of those in-between uses that make trucks appeal to such a wide audience, the Chevy and Ford are pretty evenly matched, except for the high-visibility interior areas where GM has shot itself in the foot one more time.

In the end, the choice may come down to whether your daddy told you: "This family's always been Ford (or Chevy)." **PM**



TREASURES OF THE TITANIC

Priceless artifacts return from the lost liner's deep-sea grave.

BY SYDNEY RUBIN
Exclusive PM Photos by
Veronique Leger

ON A SUMMER DAY, far below the choppy surface of the North Atlantic, an observer looks through a porthole aboard the French submersible *Nautilus*. A leather satchel lies in the yellow sand of the sea bed. A few feet to the right rests a silver serving tray. Gliding over the ocean floor, the minisub stops to gently retrieve a teacup, glistening white. The crew works carefully, steadily, moved by this physical connection to one of the world's great tragedies—the sinking of the *Titanic*.

Two vessels—the high tech *Nautilus*, the shattered but still mighty liner—bridge the ages in this act of recovery, shedding new light on one of this century's most poignant mysteries. Was an iceberg the sole culprit on that starlit night of April 14, 1912? Or was the sinking of the *Titanic* the denouement in a gripping tale of chance and human error?

To find out, marine engineers are relying on the state-of-the-art in submersible design. One of *Nautilus*'s two prehensile arms, capable of recovering objects as dainty as a hairpin, suctioned up a fragile cup and gently places it in the sub's marsupial basket. A 40-kilowatt NiCad battery powers *Nautilus*'s axial motor, driving one lateral and two vertical thrusters. The 26-ft.-long, 18.5-ton titanium alloy sub is capable of carrying three men for up to 130 hours to a depth of 20,000 ft., giving it the range to explore all but about 3 percent of the Earth's sea floor.

With an inside diameter of 7 ft., *Nautilus* carries an underwater telephone and an acoustic broadcast system for still pictures. It is also equipped with scanning sonar, two photo cameras, six external lights and a sub-bottom profiler. A Navis positioning system is used to orient *Nautilus* on the sea floor. Fitted to the bow for the voyage is a special RCA low-light color TV camera developed for NASA's Space Shuttle program. This modern wonder spots a

A picture of Innocence, the mirthful figure of a Cherub crosses the decades to give us a glimpse of *Titanic*'s rich interior. A larger version adorned the Grand Staircase leading to *Titanic*'s first-class section. On the facing page, Noel LaCoudre, a chemist at Electricité de France, and some of the artifacts recovered by Ocean Research and Exploration Ltd. Items include one of *Titanic*'s signal bells, a porthole, running lights, plates bearing the White Star Line crest, crystal decanters and the ship's telegraph, used to transmit bridge commands to *Titanic*'s engine room. LaCoudre and his colleagues will use a unique electrolytic process to leach salts and other contaminants from more than 800 objects.







A huge running light (top right) once fastened to one of *Titanic's* masts. A signal bell (above) reveals the remarkable state of preservation of some *Titanic* artifacts. The iron frame of a deck-bench (below) with its wooden slats long-ago consumed by deep-sea organisms.



dainty bud vase, a crystal decanter, some stained glass. In all, more than 800 objects will be recovered from the 2½-mile-wide debris field 350 miles south of Newfoundland.

Will the objects solve, or further cloud, the mystery that is *Titanic*?

Tales of treasure

Legends have spread about diamonds and riches that plunged to the bottom of the sea with the cream of British and American society on April 14, 1912. On board were the likes of American financiers John Jacob Astor and Benjamin Guggenheim.

But the treasure remained a romantic legend, a seductive "what if" hidden by the decades and the murky depths. Since 1985, all that changed following the historic discovery of *Titanic* by a joint French-American expedition, led by Dr. Robert Ballard of the Woods Hole Oceanographic Institute and Jean-Louis Michel of the French Institute for Research and Exploitation of the Sea.

It was only a matter of time, once the wreck was found, before someone would try to raise pieces of the *Titanic*. And so, the first *Titanic* treasure hunt got underway last summer when a new French-American collaboration using *Nautilus* began scooping up *Titanic* artifacts from the ocean floor.

The expedition raised exciting technological challenges for the French marine institute, and for the firm of Taurus International, which organized the voyage. For the adventurer/entrepreneurs who paid for it, the expedition raised the prospect of profit and prestige. But for many *Titanic* survivors, the salvage brought up only old and painful memories.

Ninety-year-old Edith Haisman of England, one of a handful of *Titanic* survivors, was 15 when she last saw her father. She remembers looking back as her tiny lifeboat floated into the vast, dark sea. He was visible in the blaze of deck lights, standing with a glass of brandy and a cigar, waving goodbye.

"Everything should be left exactly where it is," Edith Haisman says. Other *Titanic* survivors, and a segment of the American public,

agree with her.

But expedition organizers counter that the voyage made a significant scientific and historic contribution to our knowledge of *Titanic*. They developed new, tantalizing theories about how the megaligner sank, and recovered artifacts that will allow millions to touch the past.

"We're finally bringing *Titanic* home," says George Tulloch of Southport, Connecticut, one of the investors in the 1987 *Titanic* Expedition.

Probing the past

Despite the controversy, the expedition remains one of the great adventures of this decade. During six weeks of foraging, most from the south end of the debris field—separated from the forward end of *Titanic* by ½ mile—*Nautil*e produced prizes of immeasurable value. Blue-and-white china, silver spoons, ship's bells and gold drinking cups, running lights, a stained-glass window, a purser's safe, a bronze cherub that once held a light on one of the ship's grand staircases—all were among the objects *Nautil*e delivered to her mothership *Nadir*.

During a routine search around *Titanic*'s stern section August 20, divers found a leather valise, a surprise since common knowledge held that no organic material could survive 75 years undersea. The case, resembling a physician's bag, carried no identification tag. *Nautil*e approached the bag, opened it gently with its telemanipulator arms, and found it full of coins and about 35 pieces of jewelry, mounted with diamonds and other precious stones.

"Finding the case was beyond my wildest expectations," says John Joslyn, president of the Hollywood, California-based Westgate Entertainment Film Co., one of the investors in the expedition and producer of the *Titanic* TV special broadcast in America October 28.

John and Swiss watchmaker Carlos Piaget were among 20 mostly North American entrepreneurs, calling themselves Ocean Research and Exploration Ltd., who picked up the \$2.5 million tab. For their money, they got 156 hours of state-of-the-art undersea exploration.

Everyday, weather permitting, from July 25 to September 10, *Nautil*e plunged to the bottom, taking 90 minutes to make the 2½-mile drop.

A typical dive followed this scenario: On board the tiny sub, the disembodied voice from the navigating coordinator aboard *Nadir* instructs *Nautil*e. "Turn to 100°. Then go 20 meters."

*Nautil*e pilot Georges Arnoux, lying on his chest, listens intently to the radio voice and reorients the little sub in the indicated direction. *Nautil*e creeps noiselessly toward a platter bearing the emblem of the White Star Line.

The copilot, sitting on a small chair, looks through his porthole, located at the top of what looks like an isosceles triangle at the front of the vessel. At the base are two more portholes. In front of him, just beyond the porthole, the copilot has two small television screens, giving him a remote video view of what's immediately ahead.



Crockery and dinner plate bear the emblem of the White Star Line.



Remnants of an electric lamp, a silver serving tray, and a ladle.

One of *Titanic*'s numerous chandeliers survives 75 years under sea.



Video image of a manipulator arm used on an early *Titanic* dive. It's dislodging a cook's pot. Crate of egg dishes made the 2½-mile descent with *Titanic*. Worms ate the crate, leaving dishes.



GAMMA-LIAISON PHOTO



WESTGATE PRODUCTIONS, INC., PHOTO

To his left are two more small video screens, one of them displaying the full-view action of the telemanipulator arms. With the concentration of a surgeon, the pilot retrieves a platter.

Because of fatigue suffered in workdays that last up to 13 hours, *Nautilie* crews rotate, working one day, then taking two off.

"You see nothing. It is like going down in a small elevator," says Arnoux, an electronics engineer on the French Riviera before joining the *Nautilie* crew.

Attached by a 26-ft. umbilical cord to the *Nautilie* during the last few weeks of the voyage is Robin, a small, self-propelled, bright orange-red robot that shoots video for viewers around the world.

The 176-pound robot, carried at the lower front end of the *Nautilie* when not in operation, travels under the power of four oil-filled electrical thrusters, weighing 5 kilograms each. Robin carries two 250-watt and one 100-watt quartz iodide lights, one color low-light level television camera, two black-and-white television cameras, equipment for still photography, telem-

etry multiplexer, video gear and a flash head. All the cameras are enclosed in titanium-and-steel cases.

Robin is *Nautilie*'s swimming eye and floats inside the *Titanic* wreck, shooting pictures in brilliant light in places *Nautilie* can't go.

Improvising tools

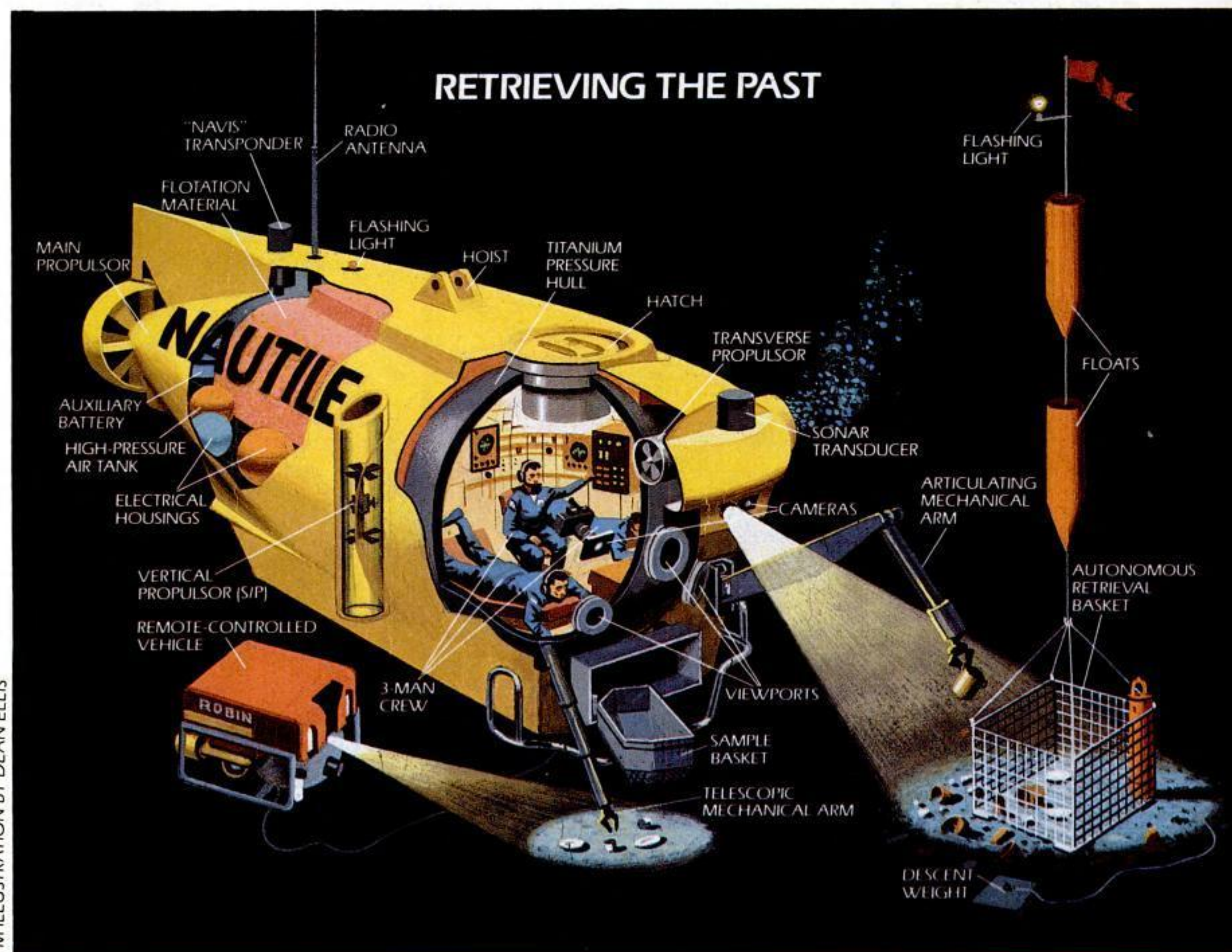
Marine engineers at Taurus, working with the French institute, devised several new pieces of equipment for the project, all of which performed flawlessly during 32 dives.

A variety of cleverly fashioned, buoyant shuttles were used to ferry to the surface objects as light as a cork and as heavy as a propeller. The special suction device for the *Nautilie* arms were created and tested last spring on some supermarket plates tossed into the ocean.

"The designs are simple and clever," says Taurus Chief Robert Chappaz, 37, who managed offshore oil projects before the *Titanic* project.

Other artifacts were brought to the surface using boxes and baskets of differing shapes. The containers were tethered to lead descent

French submersible *Nautilie* used an ingenious shuttle system made of floats, a basket and descent weights to carry artifacts to surface recovery teams.



PM ILLUSTRATION BY DEAN ELLIS

weights, then sunk to the salvage site. After being filled with *Titanic* artifacts, the shuttles were cut loose from their weights and allowed to float freely to the surface, where they were later recovered. The shuttle floats were made of syntactic foam—spheres of hollow, air-filled glass ranging in size from 10 to 200 microns—packed in a pressure-resistant resin. Attached to the floats were flashers to aid in finding the load. The shuttles devised for *Titanic* will be used in future projects, Chappaz says, to multiply the payloads for the small submersible.

Preservation is critical

On the surface, the objects were packed in fresh water to protect them from light and air, then taken aboard the 200-ft. tender *L'Abeille Supporter*. The boat, captained by Yvon Rowach, 49, a former officer aboard the *SS France*, put in at a military port in Brittany September 19. An orange shipping container bearing the recovered objects reached a laboratory outside Paris the next day. The lab, created by the state-owned Electricité de France to do metal-surface studies for nuclear powerplants, branched out in the early 1980s into a number of different fields, including marine archeology.

Technicians at the lab had previously handled material ranging from Napoleon's iron cannon to a 14th-century leather shoe. Under an agreement with the Egyptian Antiquities Organization, the lab explored for hidden cavities in the pyramids and produced a computer-generated model of a Pharaoh's temple. The articles from *Titanic* presented a unique challenge.

"I'm a little worried about one object—the captain's megaphone—since we haven't identified the metal in it yet," says Jacque Montluçon, 43, of EDF.

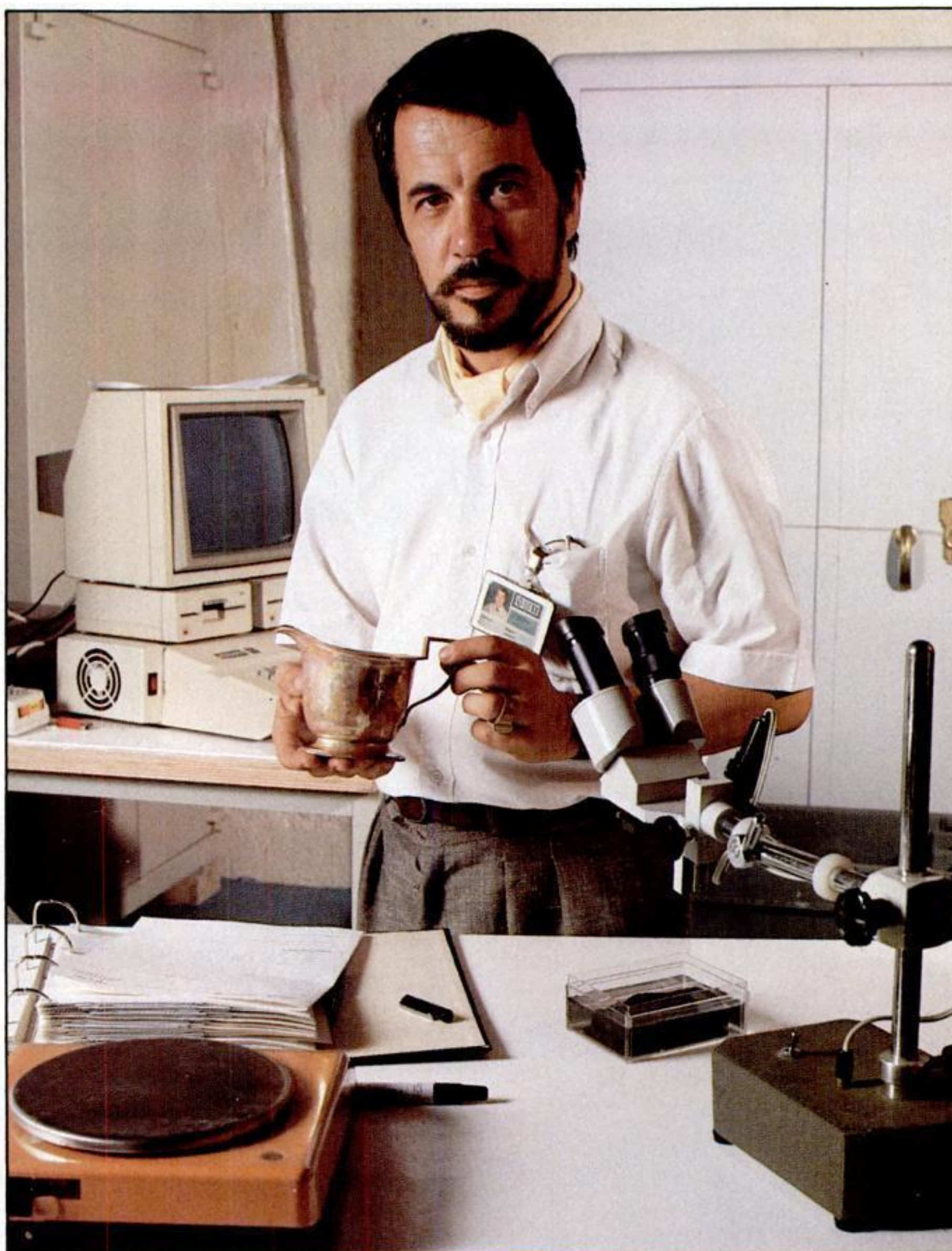
Objects were packed in salt water containers at the *Titanic* site and transported with styrofoam cushions to prevent breakage. They would have crumbled within days if exposed to air. If the salts that permeate each piece react with hydrogen and oxygen in the air, highly corrosive hydrochloric acid is formed. Other contamination is caused by hydroxides, oxychlorides, carbonates and sulfides.

EDF's unique preservation method involves passing a controlled electric current through a solution, which leaches the salt and other contaminants out of the objects.

Montluçon is excited about the prospect of restoring a sheet of wet, 75-year-old newspaper found aboard *Titanic*, to be brought into its original state without damaging the ink.

The preservation work will bring the mission's total price tag closer to \$10 million. Investors plan to recoup this investment through marketing and television rights, video and photograph sales, and tickets to a traveling *Titanic* exhibition.

But a number of large, important museums say they aren't interested. The Smithsonian in Washington, D.C. and the National Maritime Museum in Greenwich, England, say they will not accept *Titanic* artifacts for display.



Complicating exhibit in the U.S. is a Senate resolution introduced by Lowell Weicker (R-Conn.) forbidding any memorabilia from the *Titanic* being brought into the United States with an "eye to profit."

George Tulloch says that profit notwithstanding, the public has much to learn from the latest *Titanic* expedition. He points to evidence suggesting that the real cause of the tragedy was the explosion of a small but still smoldering coal fire cited in several early *Titanic* studies. The fire was reportedly centered in a coal storage bin on the starboard side forward.

Nautilie divers found an 11x14-ft. hole in the starboard side forward where the hull's metal plates were forced outward, presumably by the force of an internal explosion. Tulloch speculates that the pressure from the iceberg on the hull caused a spark or some other type of electrical failure that ignited the coal gas and sent *Titanic* to her doom. "The iceberg alone wasn't enough to do it. But we think the iceberg may have been the trigger that set off the bomb that was waiting to blow inside *Titanic*."

Robert Chappaz adds an emotional note to a story that's still not finished: "Since I was a boy, I've been fascinated by the story of the *Titanic*. But I always thought the story was missing something. Now, I'm convinced we have found the truth."

FM

Jacque Montluçon heads Electricité de France's efforts to preserve *Titanic* artifacts. His team is using computer archiving systems and unique electrolytic methods.

AIR POWER

Now emerging from the nation's top-secret drawing boards, a new generation of advanced-technology aircraft combining speed, stealth and versatility.

BY TIM COLE, Science/Technology/Aerospace Editor,
and JOSH EPPINGER;
PM Illustrations by Attila Hejja



The Advanced Technology Bomber
—with vectored thrust, radar-absorbing
materials and a low silhouette—
penetrates enemy airspace at Mach 1.

© Attila Hejja '87

FAST. Low. Virtually invisible.
Deadly.

The words describe the Advanced Technology Bomber, a crucial leg in America's nuclear triad that will join the Strategic Air Command in the mid-1990s. Incorporating "low-observable" stealth technologies, fly-by-wire controls and an astonishing array of electronic countermeasures, ATB also represents the pinnacle of aviation achievement as the turbulent 20th

century draws to a close. Similar technologies designed for light weight, high strength, increased range and payload, accuracy, survivability and maintainability are finding their way into a broad range of currently emerging aircraft. The latest developments include YF-22A, the Advanced Tactical Fighter and an entire family of advanced rotorcraft. The V-22 Osprey, scheduled to take flight in 1991, will be the military's airborne workhorse. Other high-tech

VERTOLs on the drawing board include LHX, the next generation light scout attack helicopter, designed to counter a rapidly expanding East Bloc armor threat; and X-Wing, the rotorcraft that will fly "map-of-the-Earth" at 30 knots to support ground forces, then accelerate to high subsonic speeds to engage enemy fighters.

Each is designed to perform a highly specific function on tomorrow's battlefields. They represent enormous prob-

2000



lems—and amazing possibilities—in the dynamic world of aviation technology.

Advanced Technology Bomber

We begin with the biggest—and clearly most secret—airplane construction project in American history. To fulfill the Air Force's requirement for a "long-range bomber that incorporates low-observable technologies," Northrop Corp. was awarded a \$36.6 billion contract (in 1981 dollars) to produce 132 Advanced Technology Bombers. These will complement the 100 Rockwell International B-1B bombers currently joining the Strategic Air Command.

Preliminary visions of ATB focused on Northrop's post-WWII YB-49 flying wing, an airframe that lacked severe surface angles and was thus considered difficult to track with radar. However, known control difficulties with flying wings—and a thickened, drag-inducing wing cross-section to accommodate payload—has most likely eliminated the concept from consideration.

Instead, numerous industry experts interviewed by POPULAR MECHANICS foresee a large conventional aircraft with a small cross-section in profile and nose-on. A blended shape between the fuselage and the slightly down-sloping wings will eliminate the hard intersections that bounce radar signals. A smooth, hard "chine" will flow from the forward wing-fuselage intersection

around the nose of the aircraft to provide additional nonintrusive sculpting, much like the shape of the forward fuselage of the SR-71 "Blackbird," America's high-flying reconnaissance plane.

Thrust vectoring through 2-dimensional exhaust nozzles will play a major role in control and stability, eliminating the highly observable vertical control surfaces in the tail. A refrigerant will be pumped through the exhaust outlets to reduce the aircraft's thermal signature. Positioning the engines—most likely improved versions of the General Electric F-101 currently serving in the B-1B—deep inside the airframe will further limit thermal detection. Early speculation placed the ATB's four engine inlets—hard, angular surfaces that are difficult to mask from radar—on top of the fuselage.

However, it's felt that placing inlets anywhere but on the bottom of the airplane will lead to air starvation at high pitch angles and during tight terrain-following maneuvers. Accordingly, air intakes will be placed on the underside of the fuselage. But they will open and close through a variable geometry system. High-speed flight will force more air into the intakes, thus requiring a smaller, less visible, aperture. The aperture will increase in size during slower flight over friendly territory.

The resulting shape of ATB will have a radar cross-section one-half that of the B-1B, which in turn has a radar cross-section $\frac{1}{100}$ th that of the aging B-52. And like the B-1B, ATB's objective will be to fly at high subsonic speeds under an enemy's radar and fighter umbrella to strike targets with extreme accuracy. A chief bombing objective might be rail-based ICBMs that change their launch position frequently. Satellites will detect the movement of these mis-

siles and transmit their locations to the national command authority, which will send coded target information to the ATB enroute. The ATB crew can change their flight plan or return to base if requested to stand down—a flexible response not afforded by cruise or intercontinental ballistic missiles.

To carry out its mission, it's conceivable the Air Force will reduce the ATB's flight crew to three from the B-1B's current four. A pilot/copilot will manage the flight from the forward cockpit. An offensive/defensive weapons systems officer will monitor enemy threats, jam enemy sensors, release expendable countermeasures in the form of chaff or flares and drop ordnance. The copilot and weapons systems officer would share some of the work of delivering the load in this scenario.

With an ultralow radar cross-section, the Air Force could afford to create a larger aircraft capable of carrying up to 125,000 pounds of ordnance in multiple stores bays internally. The B-1B currently holds 75,000 pounds inside, and a potential for 50,000 pounds of cruise missiles or other weapons on external hardpoints. The payloads are awesome compared to the 4000-pound bomb loads carried by the B-17. Fewer crew and a correspondingly smaller crew compartment will mean more room for electronic countermeasures, actual weapons and fuel. Unrefueled range will increase well beyond the B-1B's current 6100 nautical miles—a 15-percent increase to 8580 nautical miles has been discussed. Bomb loads will consist of a follow-on generation of the Mark 82 gravity bomb, short-range attack missile, long-range advanced cruise missile, and, potentially, antiradiation cruise missiles that can knock out enemy targeting installations in advance of a strike.

Key features of ATB will be the latest



advancements in radar absorbing materials (RAM) that absorb microwave energy; materials like high-tensile-strength reinforced carbon-carbon, thermoplastics and ferromagnetics. The paint surface, too, will be of a radar-ablative substance. Pyramid- or cone-shaped shells lined with ferrites and positioned just under the leading edge of the wings and fuselage will capture and absorb radar energy.

In short, the ATF fleet will be a potent and formidable component in America's nuclear arsenal. While optimistic progress reports continue to emanate from Northrop Corp., it's highly doubtful the Air Force will be able to conduct the first flight of ATF in late 1987 as originally scheduled. A flying proof-of-concept aircraft in late '88 or early '89 is more realistic, according to Air Force insiders.

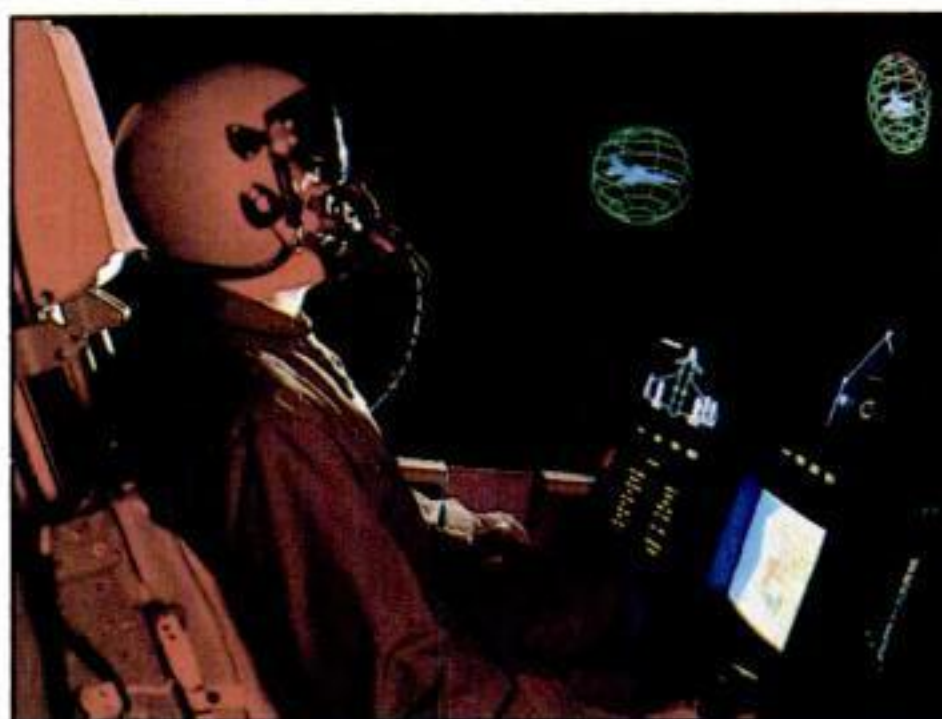
The Advanced Tactical Fighter

The Air Force colonel is like John Madden diagramming a delayed draw.

"The Soviets have been gradually increasing their fighter force with a look-down, shoot-down capability," he explains. "So in response to this threat, I need an aircraft to cross over and take them on, to engage them. Therein lies the requirement for the Advanced Tactical Fighter."

The speaker is Col. James Fain Jr., director of the Advanced Tactical Fighter (ATF) system at Wright-Patterson Air Force Base outside Dayton,

ATF will include a smart cockpit, "low-observable" technology and canard-induced "super-maneuverability." A proposed 3-D threat indicator "floats" in an ATF concept cockpit (below).



Ohio. "If we don't respond to the threat, we lose the capability to conduct air combat maneuvers. In short, we lose air superiority. And that's the thing we can't tolerate. We've learned that in war after war. We must have air superiority or we don't have a chance."

Northrop, partnered with McDonnell Douglas, and Lockheed, its Los Angeles-area rival, teamed up with Boeing and General Dynamics, are currently going nose to nose to develop two prototype ATFs over the next 41 months. The contracts are worth \$691 million each, and defense industry executives are calling it "one of the bloodiest competitions in the history of the aircraft business." The winner will waltz away with a production contract that calls for 72 aircraft a year, at least to the year 2005, or until 750 of the ATFs roll to the

chocks at U.S. Air Force Tactical Fighter Wings around the world.

In awarding the two contracts, Air Force Secretary Edward Aldridge says the new offensive fighters will be needed to counter two Soviet supersonic, all-weather fighters—the MiG-29 Fulcrum and SU-27 Flanker. Both Soviet planes are twin-engine, high-performance machines with improved range, thrust-to-weight and maneuverability. They can carry powerful long-range radars and radar-guided missiles for both dogfights and for beyond visual range, with look-down, shoot-down capability.

Also locked in heated competition are Pratt & Whitney and General Electric for the propulsion that will power this aircraft. They were awarded contracts in 1983 to develop the prototype ATF engines and are rushing to build an engine that satisfies the Air Force's thrust-to-weight ratio of 1.2:1 or better. That means if the aircraft weighs about 50,000 pounds, 60,000 pounds of thrust is required.

Although many of the details of the ATF are cloaked in a black shroud of security, Gen. Lawrence Skantze, commander of the Air force systems command, dropped more than a few hints in a speech last year. He said, "The ATF will leave the transonic flight era behind and thrust us into the age of sustained supersonic combat."

"The cues an adversary will use to try to hunt it down—like infrared, visual radar signatures—will be reduced with low observables technology. Stealth



Slats in X-Wing's rotor will create lift in transition from vertical to horizontal flight. Plane will fly low-level attack, and engage fighters.

will also reduce vulnerability to ground-to-air missiles.

"An integrated electronic warfare system will reinforce the ability to penetrate enemy airspace undetected. An avionics architecture called Pave Pillar will fuse masses of sensor information for a totally integrated avionics suite. With VHSIC (Very-High-Speed Integrated Circuits) we'll require only about $\frac{1}{11}$ th as many integrated circuits as presently used in aircraft electronics. That means far fewer cables and connections, for fewer failures at a fraction of the cost.

"The fighter will aid the pilot in making split-second decisions using artificial intelligence and other technologies like helmet-mounted displays and sights. The Air Force is working on computer voice-recognition and advanced control and displays so the pilot will be able to communicate with his aircraft, and ask for particular displays of data to be superimposed over his visor."

The general is referring to a "pilot's associate," a combination of advanced computerized systems, crammed with artificial intelligence that will help the pilot survive. It will feed the pilot, in simple graphic form, information relative to his own aircraft, mission planning, the enemy's attack, tactics to utilize and communication with aircraft subsystems. The computer systems will have speed, visual and tactile modes. They will utilize infrared, laser and radar sensors in a target recognizer that "looks" at an object—even from a long distance, creates a computerized model from memory of what it thinks the sensors are "seeing" and then compares data from the sensors against the model to determine what the object really is. The single pilot will not be bogged down with an onslaught of numbers and letters. Instead, he will be presented with full-color, programmable, pictorial formats for real-time decision-level systems and mission information. Boeing is even studying the feasibility of incorporating a third dimension to the images pilots will see on pictorial displays. The

single pilot of the ATF will thus be able to concentrate on his number one priority—the mission at hand.

At \$35 million each, the ATF will be the most expensive fighter plane ever to take to the air. It will be able to cruise supersonically at 1.5 times the speed of sound or 1300 mph. It is expected to double the combat radius—out to 1000 miles from its base and return—as well as fly twice as many combat missions in a given period of time. It will also have triple the engine reliability of the current F-15 Air Force fighter, designed in 1969. To create a plane with both range and speed, the ATF is being forged from new materials. Plastics may have been the cry of an earlier generation. Today it is thermoplastics. From 40 to 60 percent of the ATF's structural weight will consist of thermoplastic matrix composites. This will enable the aircraft to fly with the same payload and range at half the empty weight of existing fighters. This should make the ATF 20,000 pounds lighter than fighters built from conventional metal alloys.

Dr. Gary Denman, director of the materials laboratory at Wright-Patterson, explains the use of thermoplastics. "It's kind of like Tupperware," he says. "It's tough and if you ever put it on the stove, you'll know it melts. It's easy to form. But chemical companies are looking hard at ways to improve the temperature capability of thermoplastic materials and I imagine most of the ATF will be made up of them."

To maximize lift and minimize drag for fuel-efficient cruising in the ATF, variable camber wings will automatically change their curvature in flight. Preliminary testing with mission adaptive wings (MAW) on an F-111 operated in a manual mode are coming close to goals of range increases of up to 25 percent for typical supersonic, low-altitude missions and up to 30 percent for normal high-altitude missions.

There are no conventional flaps, slats, ailerons or spoilers on the MAW-equipped F-111. Instead, a composite skin covers flexible leading and trailing edges whose shape is continuously and



Lightness, strength, agility and advanced electronics define LHX. Top speed: 170 knots.

AIR POWER 2000

automatically adjusted by a digital flight control system.

Less is known about the Navy's version of the advanced fighter, the ATA. The Navy has imposed a black security net over the aircraft, but aviation experts reason that the ATA's needs will still be tied to the large-deck aircraft carrier.

The New Rotorcraft

Igor Sikorsky would be aghast. The pioneer of vertical flight would never have imagined that his creation—the helicopter—would one day mesh with such a variety of VERTOLs able to fly at high subsonic speeds. That day is now. Rotary-wing technology is lifting off from the drafting tables at accelerating speeds, with a variety of configurations serving a number of missions. PM looks at the latest creations: the X-Wing, the LHX and the V-22 Osprey.

The X-Wing

The X-Wing, currently undergoing its first tests at NASA's Dryden Flight Test Center at Edwards Air Force Base in California, is an aircraft that takes off and lands vertically, hovers with helicopter-like efficiency and control, then flies at high subsonic speeds. Developed by Sikorsky, the X-Wing is the first aircraft to use a lift and control system to transform its large-diameter rotor into an efficient fixed wing.

What makes all this possible is something called the Coanda Effect—streams of air forced over a curved aerodynamic surface will follow the contour of that surface, entrain the surrounding air, and provide lift. Thus, in some 30 seconds when the rotor is stopped to become a fixed wing, pressurized air is blown through slots along

the 27-ft. length of the blades, producing both aircraft control and lift.

The X-Wing, which is first being tested on a vehicle known as the Rotor Systems Research Aircraft (RSRA) to demonstrate that it indeed can convert from rotor to fixed wing in flight, incorporates pioneering applications of composites, computer and circulation-control aerodynamics. "Here you have something that could fly map-of-the-Earth at some 30 to 40 knots when that was appropriate, go out and do helicopter dogfights and then also fly at 450 to 500 knots and do dogfights with fixed-wing airplanes," says Arthur Linden, engineering manager of Sikorsky's X-Wing project. The X-Wing will also be elemental in improving protection for Navy fleets by flying long-range patrols from small ships sailing well in advance of the main fleet. Once in position, it can then hover for sonar dipping or search and rescue missions.

The LHX

To counter the effectiveness of the Soviet Mi-24 "Hind" helicopter and replace an aging fleet of light helicopters, the Army is developing an agile, high-speed advanced family of rotorcraft in the 8000-pound class. Designed by Boeing Vertol Co. and United Technology's Sikorsky Aircraft, the LHX will field two models of a lightweight, low-cost helicopter—a scout attack version, and a utility version.

The LHX will be powered by twin 1270-shaft-horsepower engines with a top speed of 170 knots and the ability to climb at 500 ft. per minute. It will incorporate very-high-speed integrated circuits, a fiberoptic control system and advanced composites, structures and aerodynamics. One aim of the LHX aircraft is to reduce weight. Thus, composites will be a prime component of the

LHX. One version, known as SCAT, might be flown by just one pilot—assisted by a highly complex system of computer-aided avionics. The pilot will primarily focus on flying with essential flight and weapons information projected on his helmet visor. Systems will be activated by voice commands and it is conceivable the system will be able to talk back to the pilot.

The LHX will be piloted by means of a short, videogame-like stick mounted on the right armrest. The LHX's main core could consist of sensors, processors, displays and controls that will handle navigation, targeting, fire control, flight control, fault detection and other equipment—a stiff technological challenge.

The V-22 Osprey

The V-22 is a tilt-rotor aircraft combining a modern turboprop plane with the vertical take-off and landing capabilities of a conventional helicopter. It will

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PM Wall Poster

Carefully tear along perforation to remove.

cruise at 275 knots and carry combat payloads more than 1000 nautical miles. The joint Bell Helicopter Textron/Boeing Helicopter design currently moving toward production will use forward-swept-wing technology and advanced composites. It will have great utility for all the armed services: The Marine Corps sees it as a medium assault transport; the Navy for combat search and rescue, special warfare, fleet logistics and antisubmarine warfare; the Air Force for long-range insertion and extraction of special operations forces; and the Army for aeromedical evacuation, combat transport of troops and supplies and other support functions.

Bell Helicopter Textron, Inc., and Boeing Vertol Co., the tilt-rotor team, like to boast of the Osprey's potential: twice as fast as a helicopter, twice the range, can carry a comparable payload twice as far and twice as fast as today's helicopter, increased survivability and reliability, plus easier maintainability.

The V-22 will be the earliest advanced technology aircraft to enter the four services, with a first flight scheduled for 1991. But its impact will be felt far into the next century. Consider the venerable C-130. Designed in the early '50s, it's still ferrying troops and equipment. Likewise, today's concepts for ATB, ATF, X-Wing and LHX will be flying at least until 2025. More than advanced aircraft, today's aviation concepts thus become our legacy of flight. **PM**

The V-22 Osprey will take off like a helicopter and fly like a plane using tilting engines. A cross-link system operates both blades on one engine if one powerplant fails.





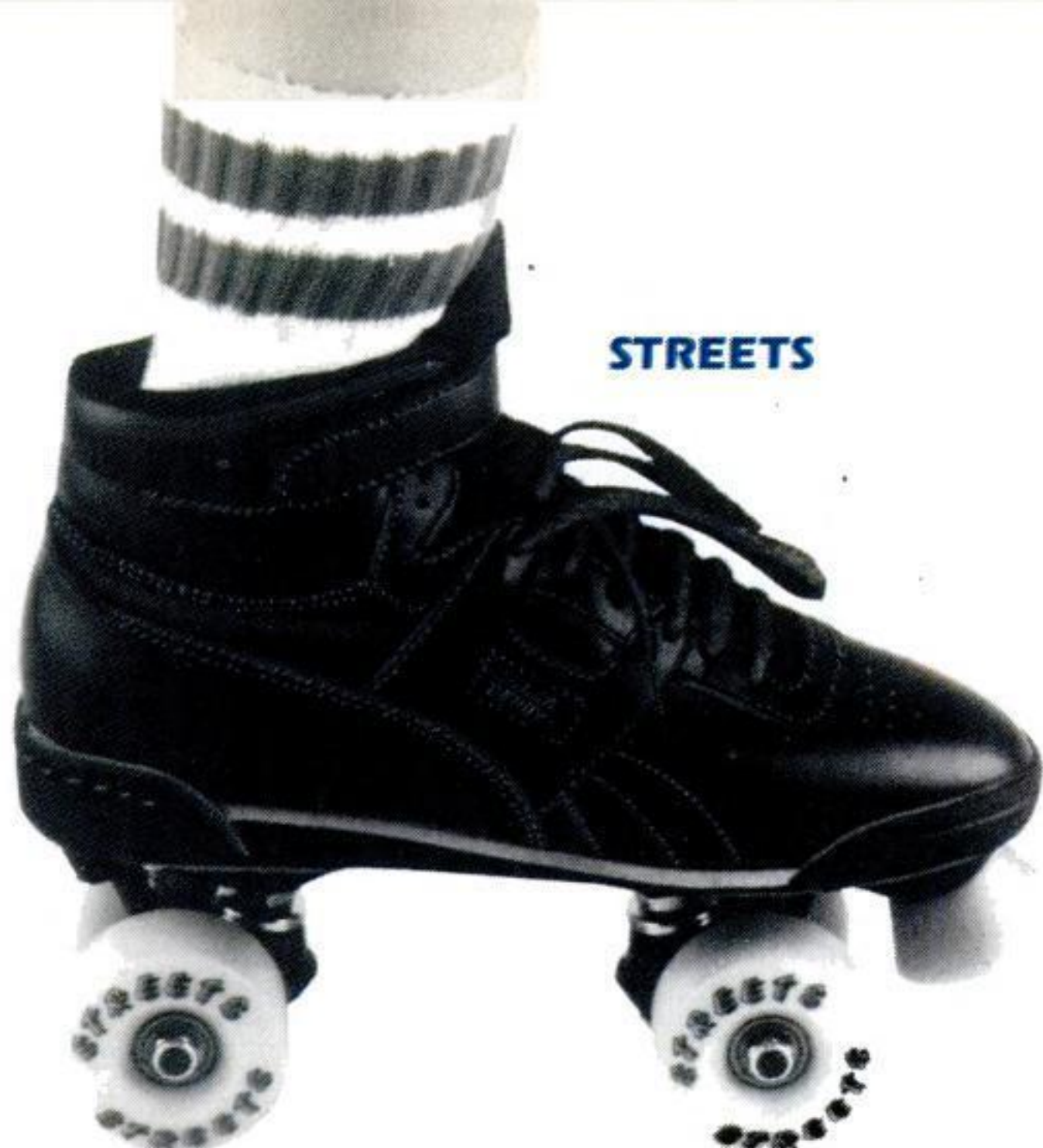
SIKATES ON A ROLL

Lighter, faster and tougher roller skates
bring an old sport back to the future.

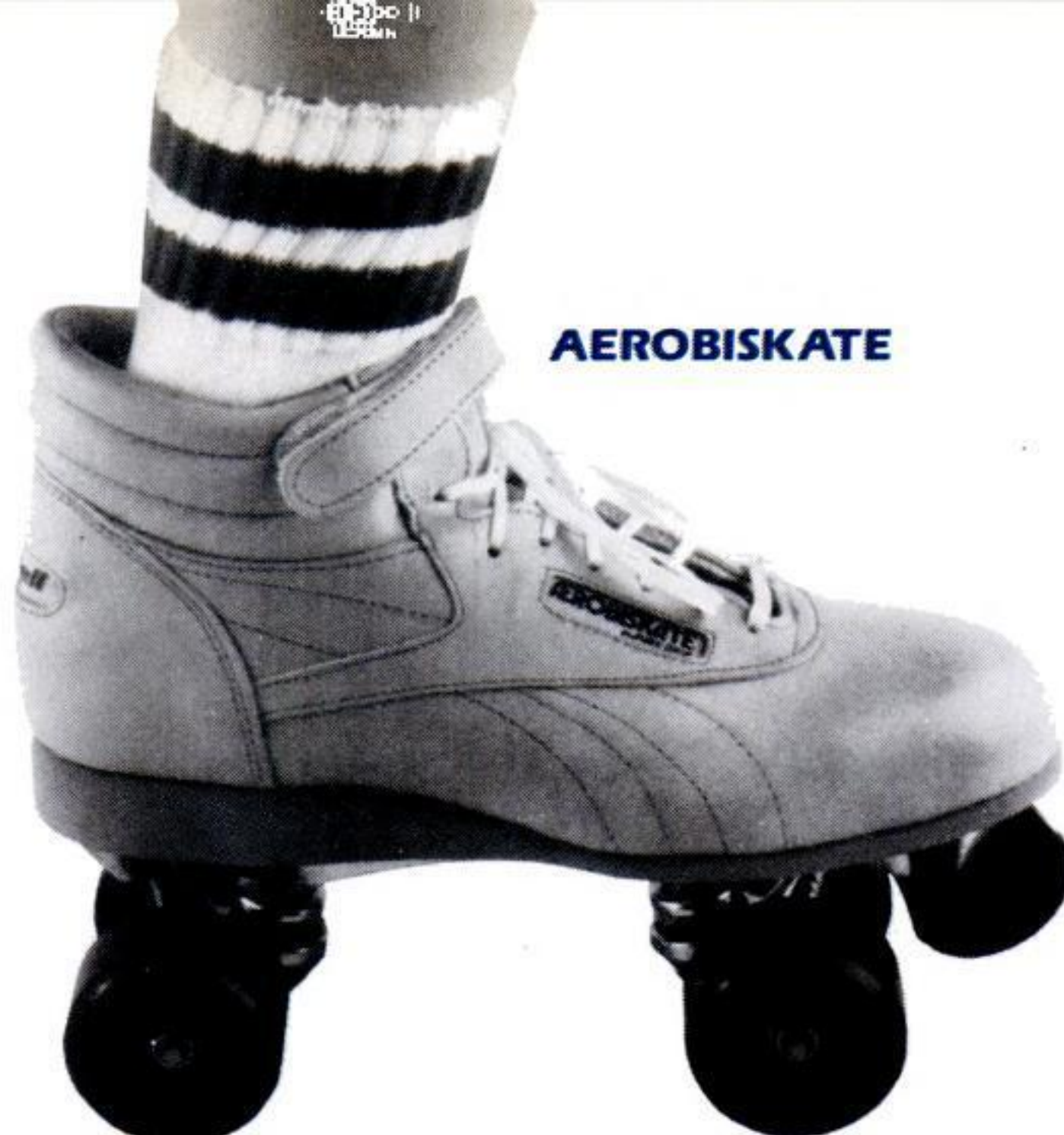
BY JOSEPH SKORUPA, Outdoors Editor, and DENNIS BURNSIDE
PM Photos by Allen Zenreich

YOUR first set of wheels aren't what they used to be. Roller skates, like most things today, are now marvels of high-tech design. Instead of the 1-size-fits-all strap-ons we remember from our early youth, today's roller skates feature 1-piece fiberglass construction and a ski-boot fit. And instead of the rubber-wheeled, leather-and-steel models in black and white that we graduated to in our teens, today's performance skates come in multicolored fashion designs made of ultralight, space-age alloys.

These recent developments are the result of a new breed of skater who dreams of leaving sidewalks and neighborhood rinks behind to compete in the Pan Am Games, star in the Broadway play *Starlight Express* or train for the 1992 Olympics, where roller hockey will be a nonmedal event.



STREETS



AEROBISKATE

SKATES ON A ROLL

A prime example of the innovative technology that's currently reshaping the sport is the Frollerskate (previous page), imported from Switzerland by The Sharper Image, of San Francisco. The most distinctive feature of the Frollerskate is its unique outer shell of hard polyurethane, which more resembles a ski boot than a conventional skate. This radical design employs a removable innershoe, which molds to the shape of the foot, and a single-buckle closure.

Equally innovative is Frollerskates' independent wheel mountings or trucks. Most skates connect front and back wheels to a plate of metal or hard plastic. Frollerskates mold the truck mountings into the rigid boot shell, eliminating the need for added support. The result is a sleek, ultramodern design well suited to free-spirited, modern skaters. Frollerskates cost \$99.

To better understand recent developments in roller skate design, let's break the skate into its essential components.

■ **BOOTS**—Frollerskates, as mentioned, are on the leading edge of boot technology, but they're still the exception to the rule.

Most skates, especially high-performance models, still use leather boots with soles made of hardened leather or rubber. Inexpensive skates may use vinyl boots. Velcro straps, either replacing laces or in conjunction with them, are a recent development. By themselves, boots range from \$20 to \$300.

■ **WHEELS**—Urethane and vanathane are the basic materials used for wheels. Urethane wheels are made by pouring polyurethane plastic into molds, and are the wheel of choice for high-performance skaters, because of their durability. Vanathane is a rubber/plastic compound that's compression molded into wheel shapes.

Hardness in skate wheels is mea-

sured by a durometer on something known as the A scale. The higher the A-scale number the harder the wheel. A good outdoor hardness is 78A to 85A. For indoor skating, 92A to 98A is best.

Quality wheels cost from about \$20 to \$200 for a set of eight.

■ **BEARINGS**—Ball bearings are a component of the wheels, but they can be mounted separately. Double-sealed precision bearings are recommended for recreational skaters. The seals protect the bearings from dust, grit and water. Competitive skaters prefer single-sealed bearings for easier accessibility during frequent maintenance. A set of 16 can cost from \$15 to \$100.

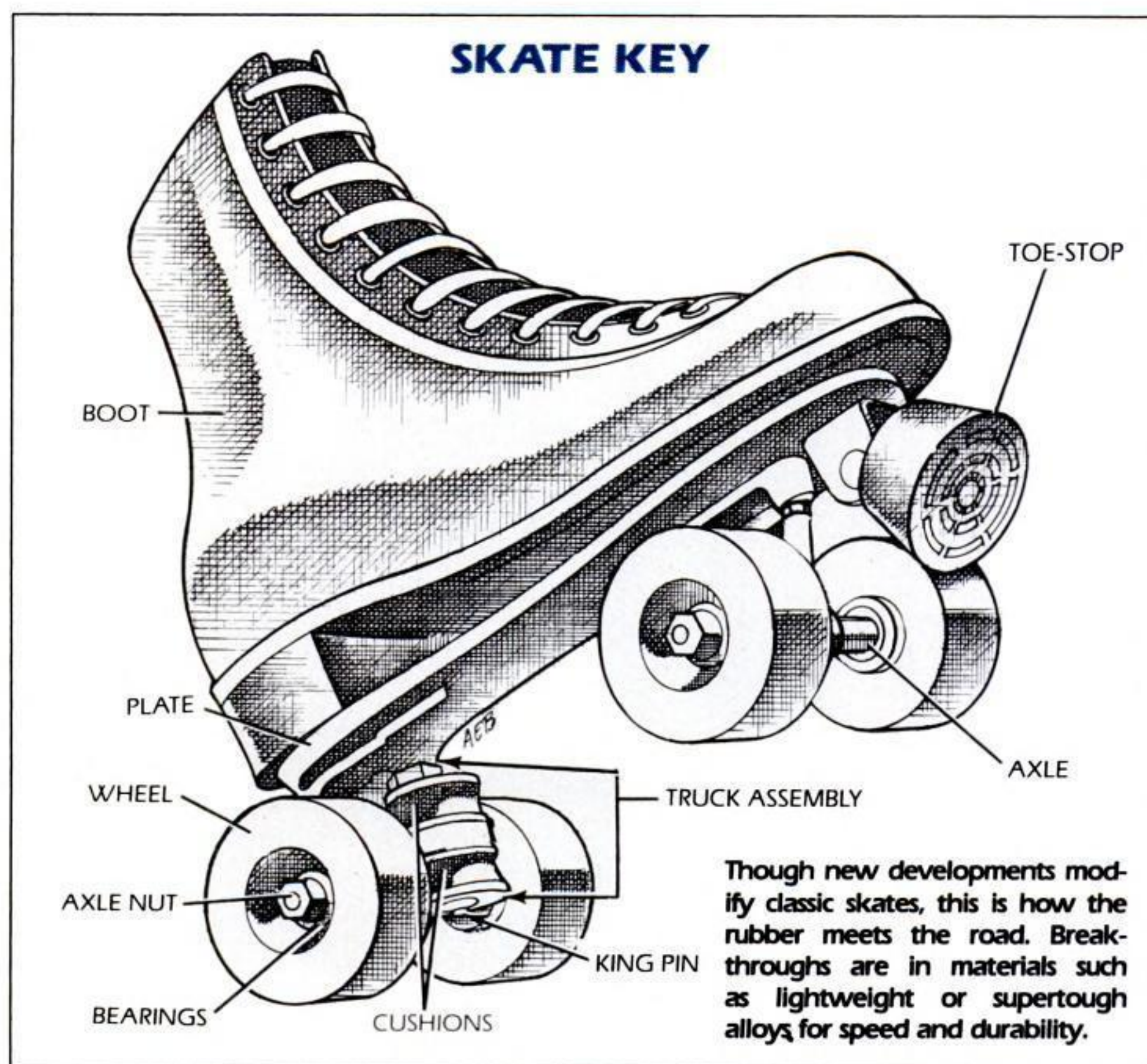
■ **SKATES**—The skate has two main

parts. One is the *plate*, a flat metal or plastic component running the length of the boot sole. The other is the *truck*, which holds the axle and is designed to flex so that the wheels can turn. There are two trucks on each skate.

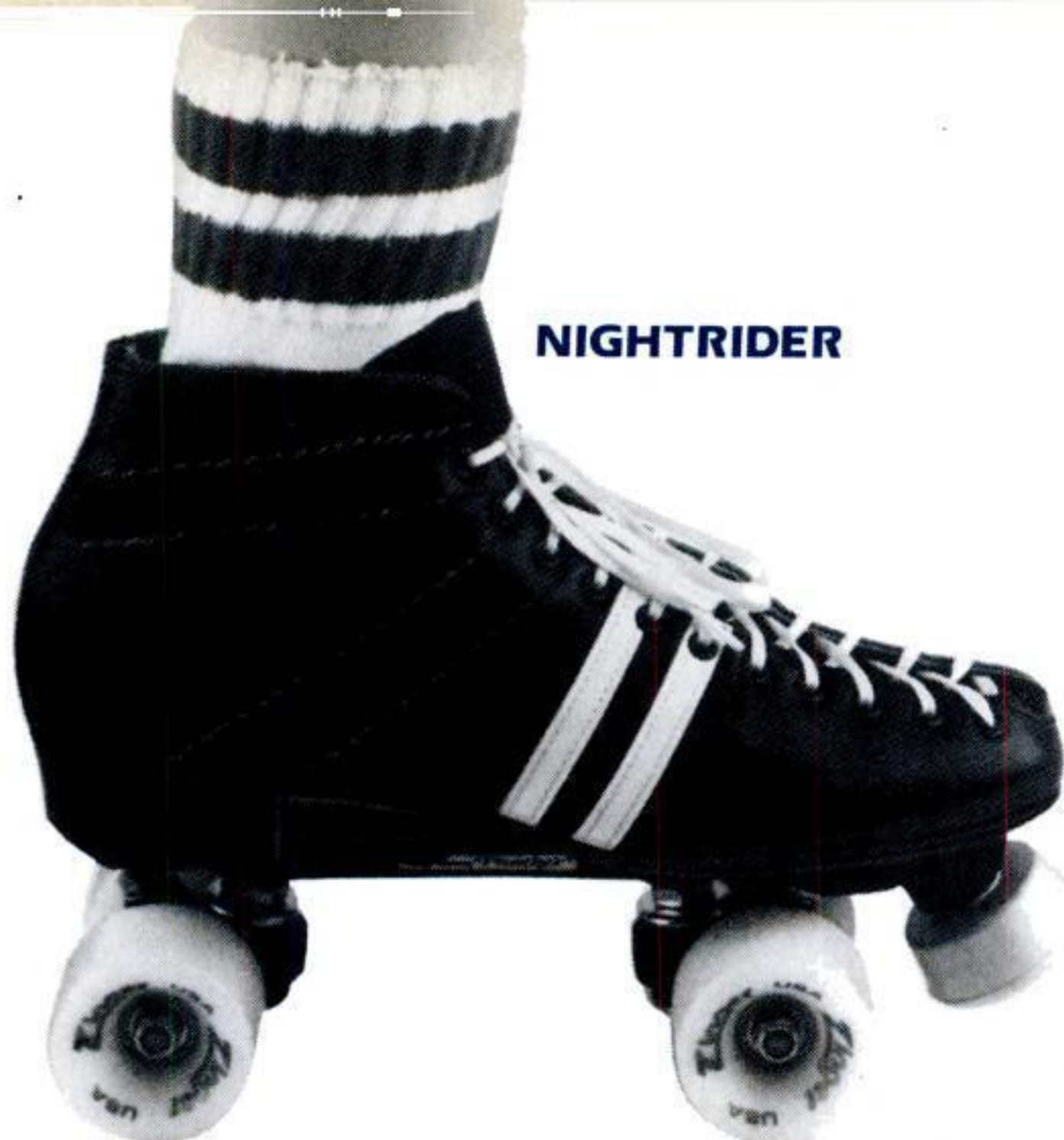
Many recent developments have taken place in skates. Steel has been replaced by alloys of titanium, magnesium and aluminum or a host of synthetic plastics, fiberglass or nylon.

Since skates—the plate and truck assembly—are the most vital component, they can run as high as \$700 for space-age alloys. Plastic ones begin at \$25.

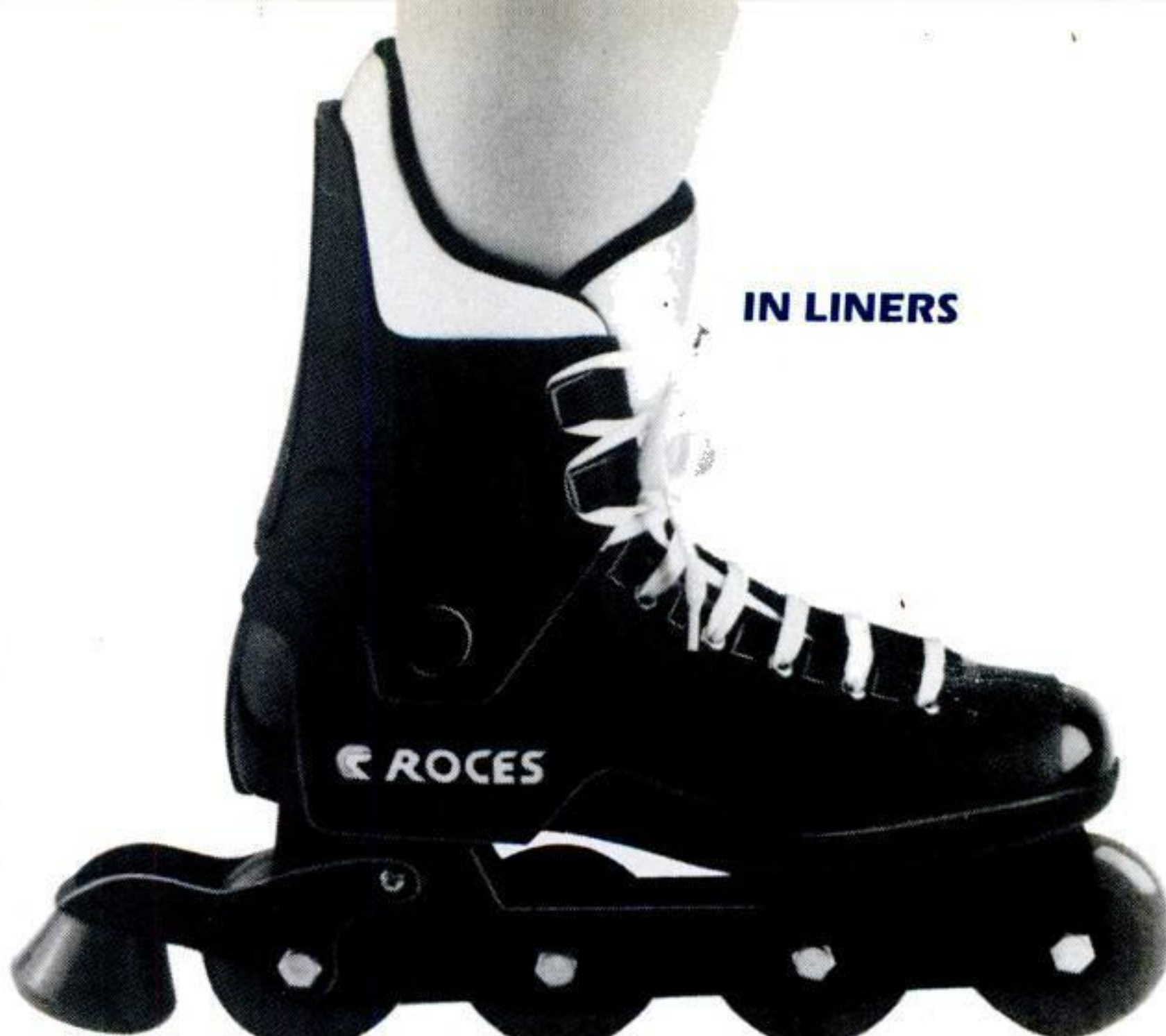
If you've been adding up component costs, you've come up with a range of about \$70 to \$1300. Despite this high



Though new developments modify classic skates, this is how the rubber meets the road. Break-throughs are in materials such as lightweight or supertough alloys for speed and durability.



NIGHTRIDER



IN LINERS

ceiling, many innovative skates can be found in \$75 to \$200 range.

One of the most popular recent breakthroughs takes its cue from the world of athletic shoes. A new skate by Roller Derby, of Litchfield, Illinois, uses a soft vinyl boot similar to a high-top basketball sneaker. Known as Streets, this new skate features well-padded upper and EVA sole, athletic-shoe support, and extended heel counters to protect against overpronation of ankle and knee joints. It also has nylon/fiberglass composite plates and trucks. Cost is \$70.

Aerobiskate, made by Sure-Grip, of South Gate, California, also uses an advanced athletic shoe design. Its top-of-the-line boot is made by Riedell Shoes,

of Red Wing, Minnesota, with a specially padded upper for comfort and a Velcro strap for support around the ankle. For maximum durability, it comes with steel skates. Cost is \$150.

For raw speed, the Nightrider, by Chicago Skate uses ultralight nylon/fiberglass plates and trucks. Its precision bearings feature high-grade machine grinding and polishing. It also has an adjustable pivot pin and double-action cushions to permit a maximum level of adjustability for increased control. Cost for this high-performer is \$235.

Hard, 1-piece boots were pioneered by skiers, but the next sport to copy it was ice hockey. Now, roller skates are following suit. In Liners, made by

Roller Derby, not only use a 1-piece boot, but replace plates and trucks with a steel chassis that positions the four wheels in a single-file formation. Mounted this way, the wheels simulate the feel of a blade skimming over ice. Professional and devoted amateurs use these skates for practice in the off-season and they are most popular in northern and urban areas. In Liners cost \$80.

As high-performance skaters keep approaching new boundaries, quadruple spin jumps and 35-mph speeds, roller skate designers use new technology to meet the demands. Invented in the 1700s and once considered past their prime, high-tech roller skates are breathing new life into an old sport. **PM**

High-Tech Skating Rolls Onto Broadway

THERE are bigger skate shops in the country, but none as dazzling as Joe Cesarelli's in New York. Cesarelli's shop is only an 8 x 10-ft. room, but it's located backstage at Broadway's Gershwin Theatre and his regular clientele is the cast of the hit musical *Starlight Express*.

Cesarelli maintains this shop—containing 80-plus skates and a large stock of supplies—for the first show on Broadway staged entirely on roller skates. Written by Andrew Lloyd Weber—composer of *Cats* and *Evita*—*Starlight Express* is a showbiz phenomenon. Its combination of high-energy music, special effects, sci-fi costumes and daredevil choreography have made it a sellout in New York since it opened last March.

Though the show is a child's fantasy about a train race, with each actor portraying a locomotive or a train car,

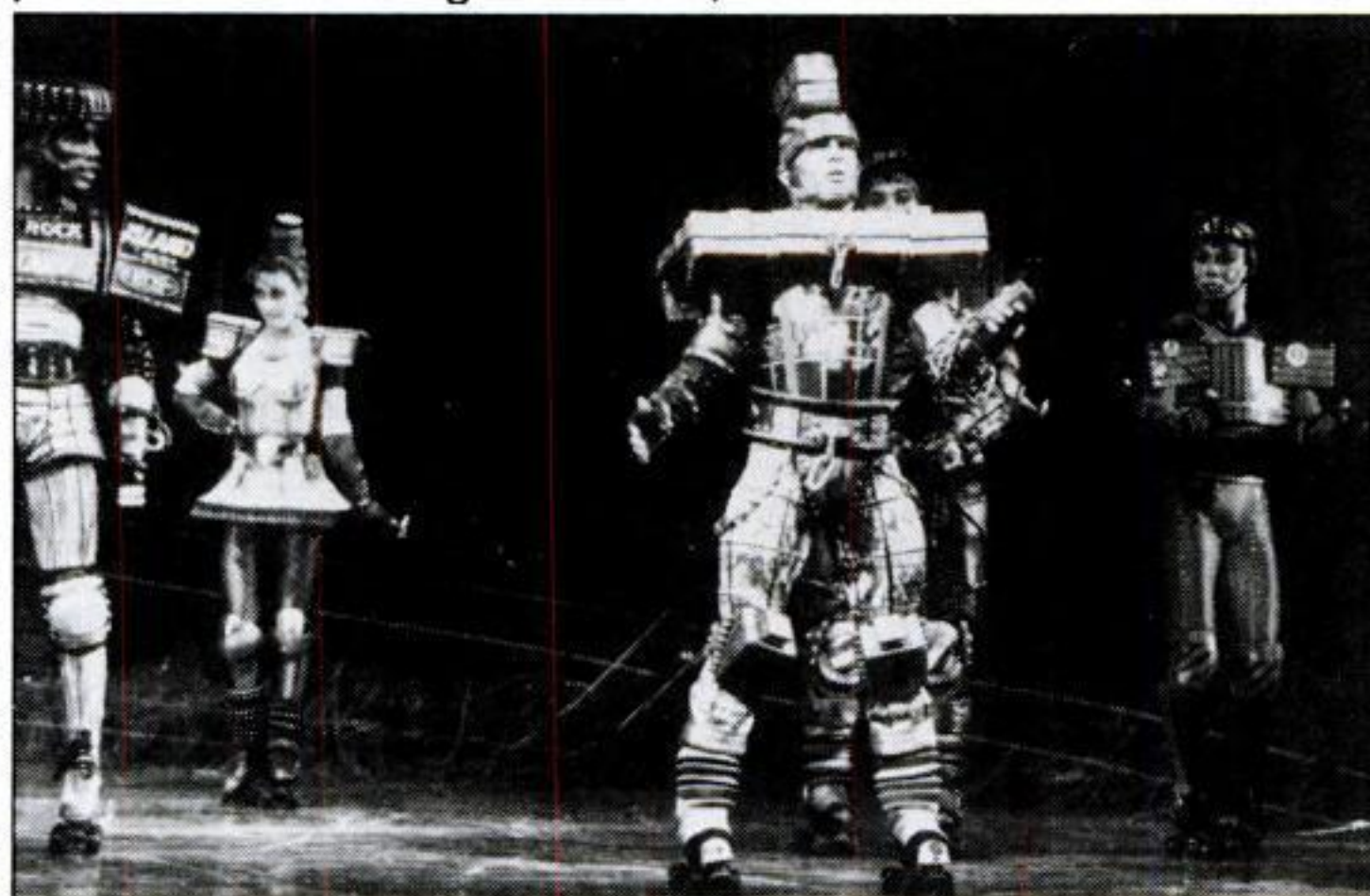
its success is a result of the exhilarating sense of motion conveyed by the roller-skating cast. Actors careen up and down a 3-tiered, high-tech stage—at times attaining speeds of 30 mph while singing, dancing and performing acrobatic stunts. Naturally, a show this demanding on skaters is equally demanding on skates, and Cesarelli ad-

mits frankly, "Skates were never meant to do what we do with them."

Cesarelli makes sure his skates are as tough and durable as modern technology allows. He tunes up every skate before every show. But despite daily maintenance, the show's stunning acrobatics put the skates through extreme stress. Toe stops are torn off posts. Plastic trucks and skates are broken in half. The skates used in *Starlight Express* are made of custom assembled components and cost from \$200 to \$500 a pair.

Though *Starlight Express* didn't set out to give roller skating a shot in the arm, that's exactly what it's doing, according to Cesarelli. One result of its impact, through videos and a future national tour, will be a new generation of skaters pushing the sport to new limits and dreaming of becoming Broadway stars.

—Joe Skorupa



Broadway's perpetual-motion dazzler, *Starlight Express*, is a demanding test for both performers and their high-tech roller skates.



PM's FAMILY CLASSICS

SNOW SPEEDSTER

Give the kids some winter excitement with a sleek, new toboggan that you can build.

BY AUGUST CAPOTOSTO

LET'S get nostalgic. It's 4:30 in the afternoon. The air is clear and cold. And, as the sun begins to set, you look up to the top of the hill and try to decide if you can get one more run in before you're expected home for dinner. Your friends are game for it. It's been too great a day to end so soon. You hear the snow crunch underfoot as you and your friends pick up the long, wooden toboggan and start carrying it up. Once at the top, you align it in its well-worn path. Maybe this time you'll break your distance record. You take your position and the guy at the back begins to push. At the last moment

(you thought he wouldn't make it), he jumps on.

As you begin your downhill acceleration, you try to mentally coax the toboggan faster. Trees flash by and—almost before it started—the ride is over. Picking up the toboggan for the walk home you notice—10 ft. further. Maybe tomorrow.

Here's your chance to provide memories like these for the children in your life. And, our toboggan is designed to last for generations. Your kids will be able to do more than reminisce, they can pass on the toboggan you made for them as well.

Beginning construction

Our ash toboggan is constructed by laminating $\frac{1}{16}$ -in. ash veneer to create the J-shaped slats. While laminating curved shapes isn't difficult, it does require preparing a form on which the wood is bent and clamped. Begin by cutting the 20 × 96-in. form base. Nail five cleats underneath to allow space for the bolt heads used for fastening the forms. We used fir plywood for the $\frac{3}{4}$ -in.-thick base, but particleboard works just as well. The forms are made out of 2x4s.

Crosscut six lengths of 2x4 stock to 9 $\frac{3}{4}$ in. and rip them to 3 $\frac{1}{4}$ in. wide. Glue these together to create the 3 × 9 $\frac{3}{4}$ -in.-



Color photo: Alex Layman
Black-and-white photos: August Capotosto
Technical art: Eugene Thompson
Photo stylist: Gabe Herrick

SNOW SPEEDSTER

sq. front form blank. Then, lay out the $8\frac{3}{4}$ -in.-dia. arc that represents the inside diameter of the bend and band saw to the line. Cut the inside profile for clamp access and the notch where the straight section joins. Choose the straightest piece of 2x4 available for the straight form and trim it to 3 in. wide and $75\frac{1}{2}$ in. long. To make the form rigid, both sections are bolted to the base with $\frac{3}{8}$ -in.-dia. $\times$ $3\frac{1}{2}$ -in. bolts. Counterbore the bolt holes so the washers and nuts will be recessed. Then, bore the bolt holes through the forms, and panel and install the bolts.

Clamping blocks called cauls are used to hold the laminations against the form. To make the front cauls, cut six pieces of 2x4 to about 1 in. longer than the $9\frac{3}{4}$ -in. finished length and rip them to $3\frac{1}{4}$ in. wide. Glue together in pairs to get the

required 3-in.-thick pieces. Trim $52\frac{1}{2}^\circ$ miters on each end to exact length. Then, lay out the outside edge profile of the front of the toboggan on a piece of cardboard. Position the mitered cauls as shown in the drawing. Then transfer the profile and cut each piece to the line. Next, trim a 2x4 for the long, straight caul to exact size. To keep the slats from being glued to the forms or cauls, apply a coat of varnish and two coats of paste wax to all the parts.

Preparing the veneer

You'll need a total of 48 3-in.-wide strips of $\frac{1}{16}$ -in. ash veneer for this project. First, crosscut enough veneer for the job to 96 in. long. To true up one edge on each piece, tape a straight length of stock to the veneer and rip the outside edge of the veneer on the table saw (photo 4). Then, rip each strip to 3 in.

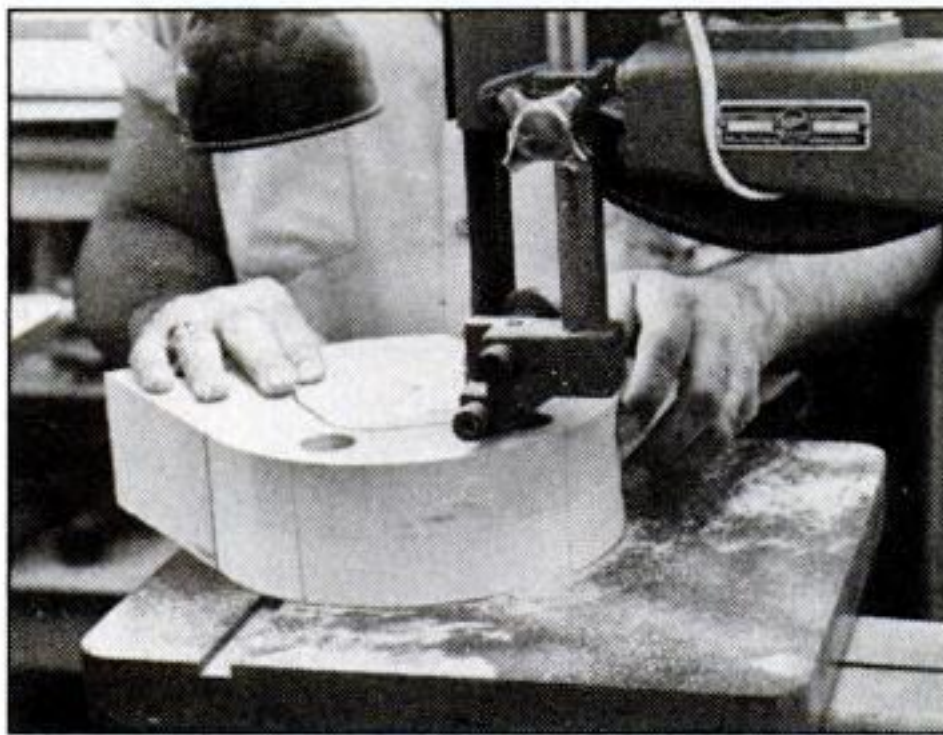
Apply plastic resin glue to the mating

surfaces of eight strips, stacking them as you go. Position the stack end at the top front edge of the form and lightly clamp the first caul in place. Make sure the veneers are in contact with the base. Bend the laminations around the form, clamping each caul lightly. Then, starting at one end of the form, completely tighten all clamps. It's a good idea to recruit a helper for this operation.

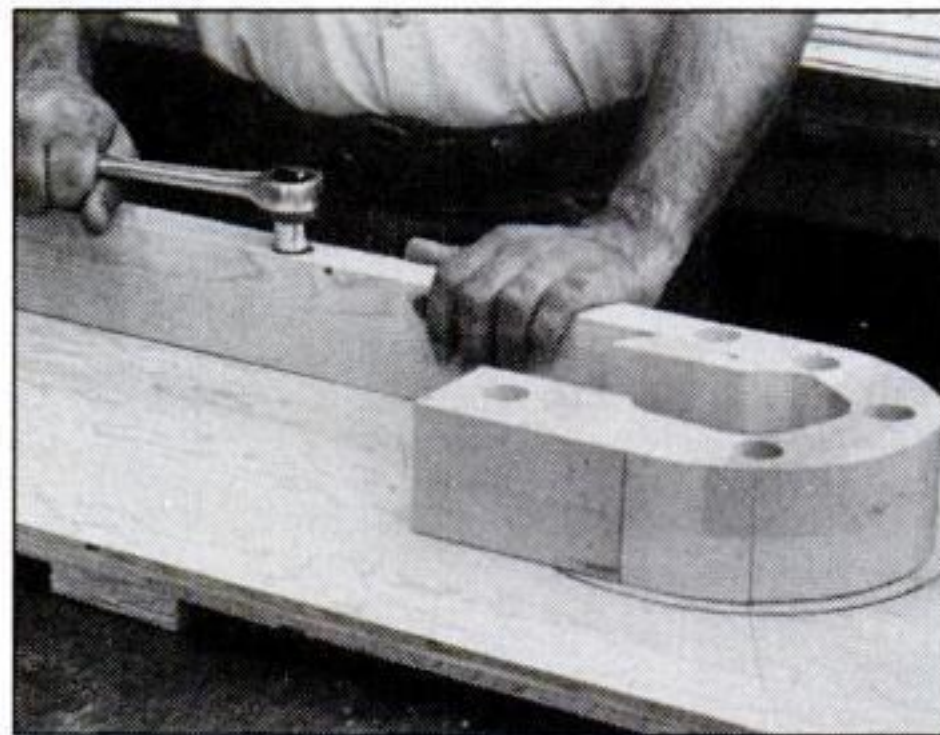
Trimming the slats

You can clean up the rough edges of the laminations with a router, straight bit and guide bushing that follows a $\frac{1}{2}$ -in.-thick plywood template positioned on top of the form. Cut the 3-in.-high template supports and screw them to the form base from underneath. The notches in the end support are useful for freeing the slats from the form after an edge has been trimmed. Then, con-

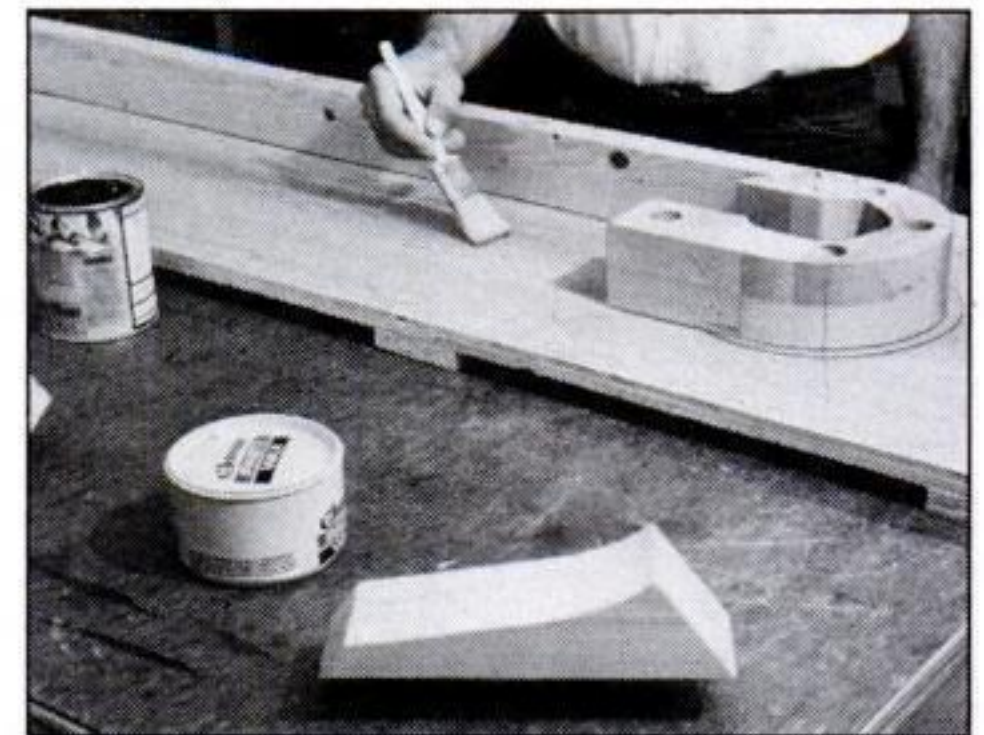
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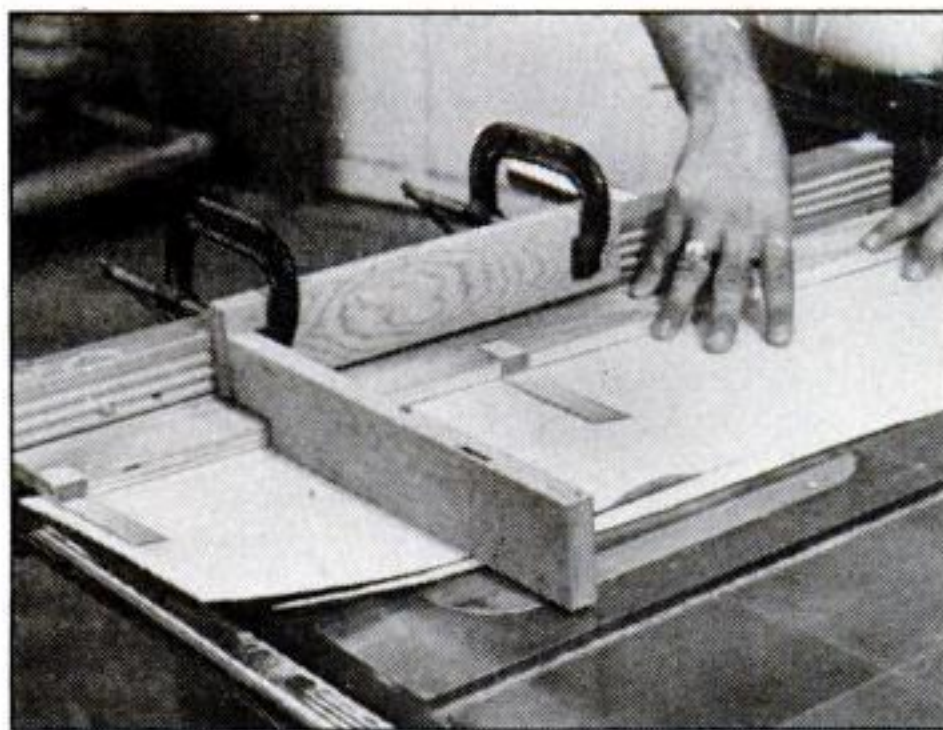
1 Glue up 2x4 stock to create the $3 \times 9\frac{3}{4}$ -in.-sq. front form blank. Then, lay out the profile and saw to the line.



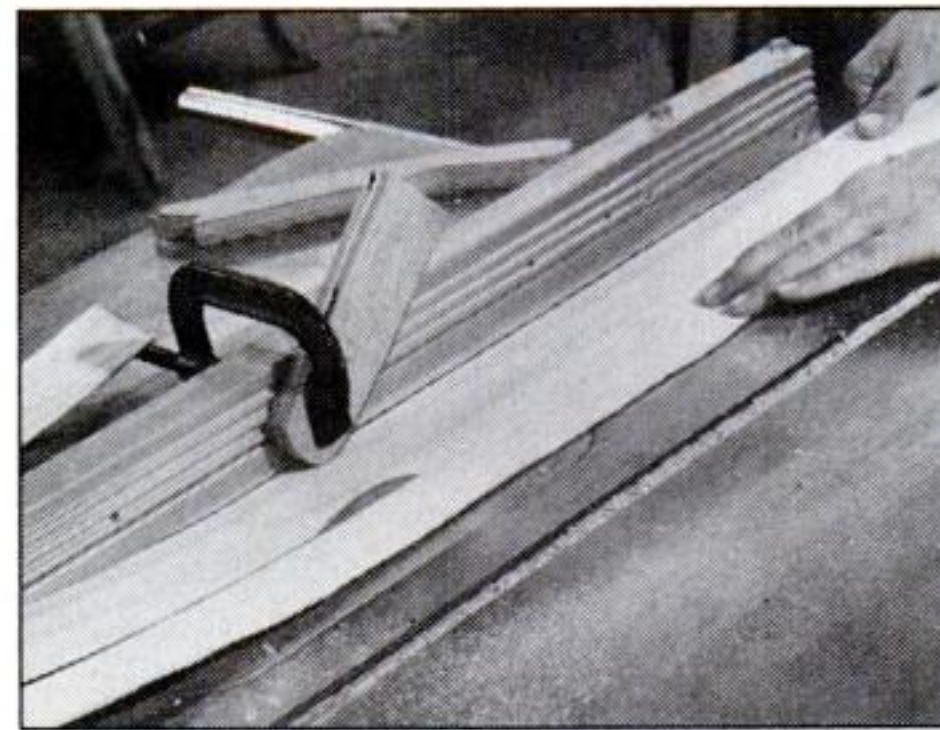
2 After counterboring holes to recess the nuts, bore $\frac{3}{8}$ -in.-dia. holes through the forms and base for the securing bolts.



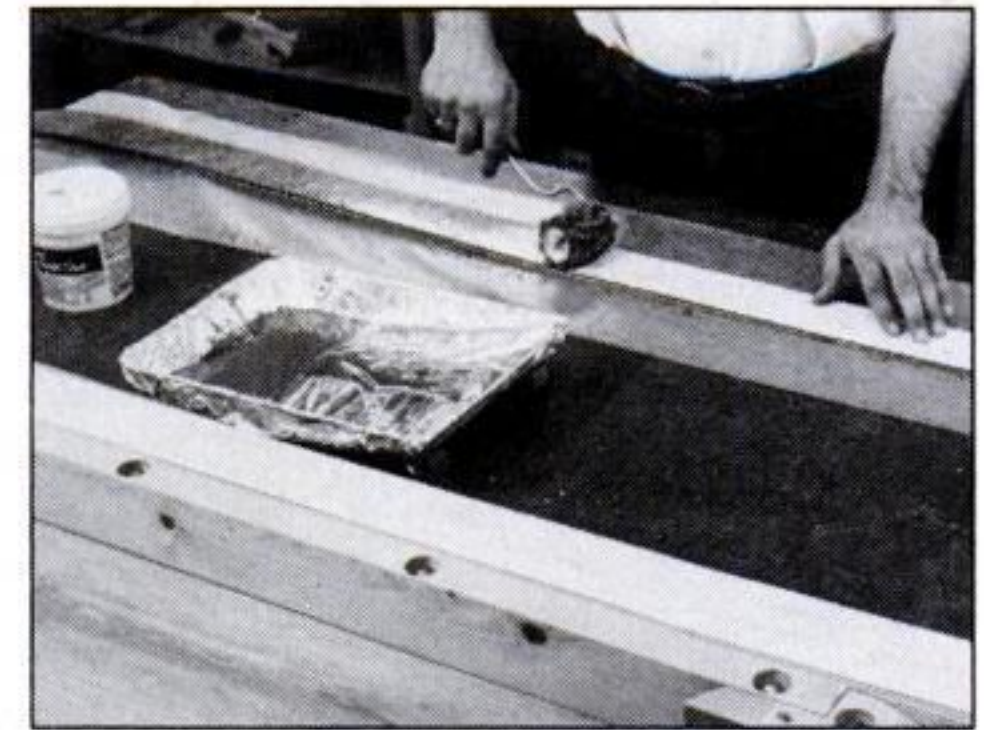
3 Keep lamination from being glued to form by applying a coat of varnish and two coats of paste wax to the components.



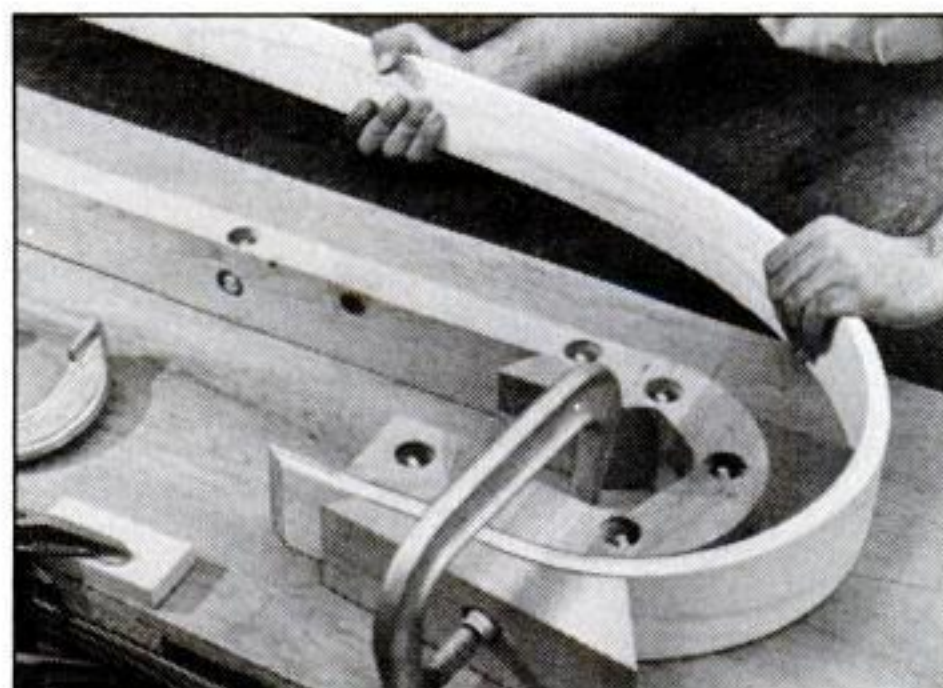
4 Tape each sheet of veneer to a straight piece of $\frac{3}{4}$ -in. stock and true one edge. Jig clamped to fence holds the veneer down.



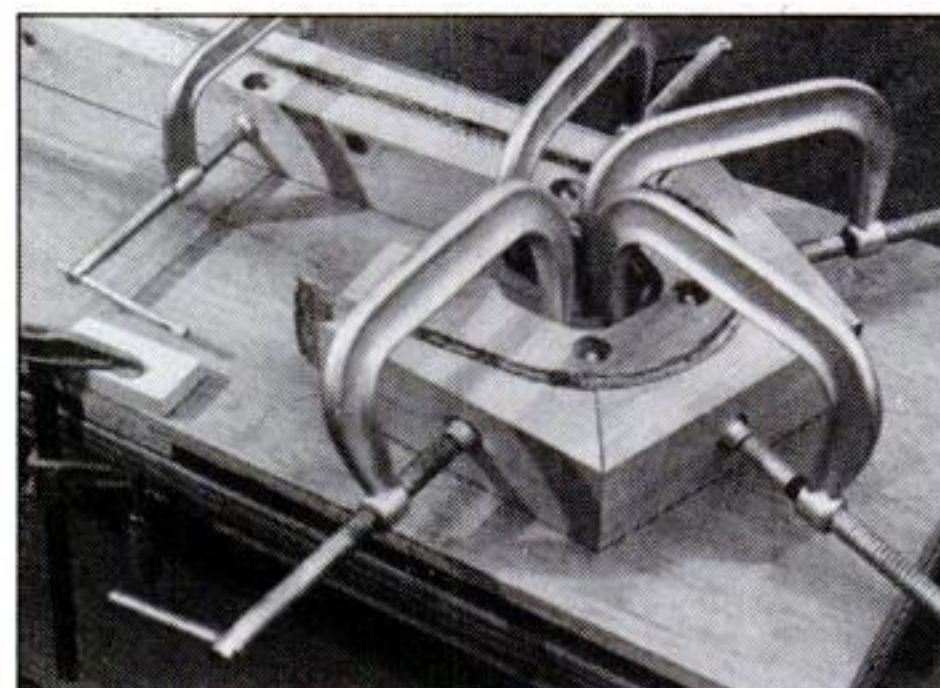
5 Rip the veneer to 3 in. Block clamped to fence keeps the strip from lifting. Use a sharp, fine-toothed blade for these cuts.



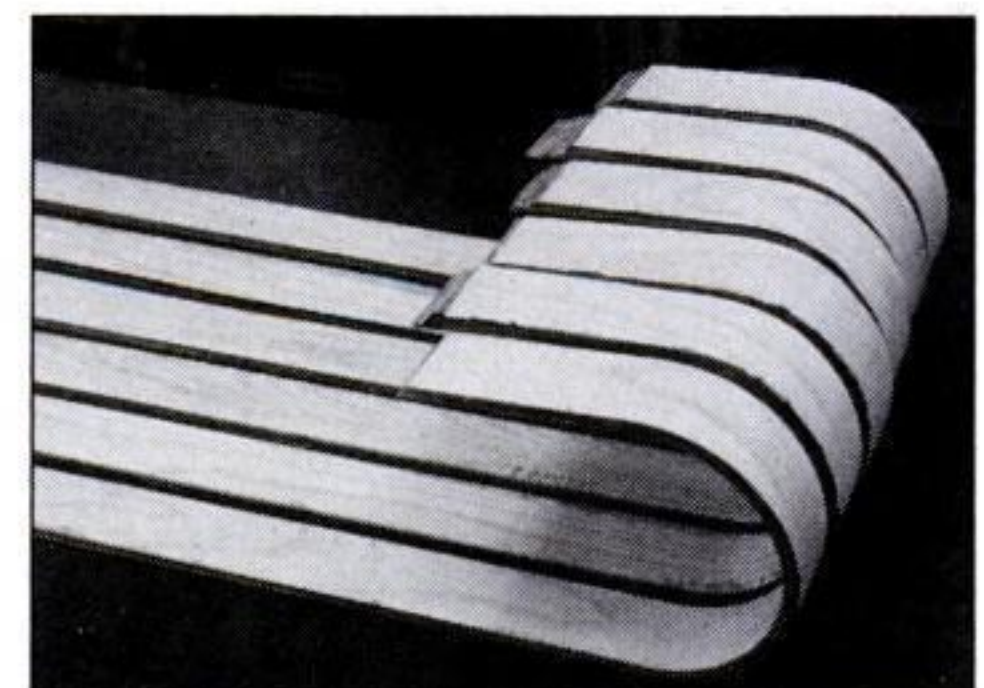
6 Prepare 1 pound of plastic resin glue for each laminated slat. Apply a uniform coat to parts with a 3-in. paint roller.



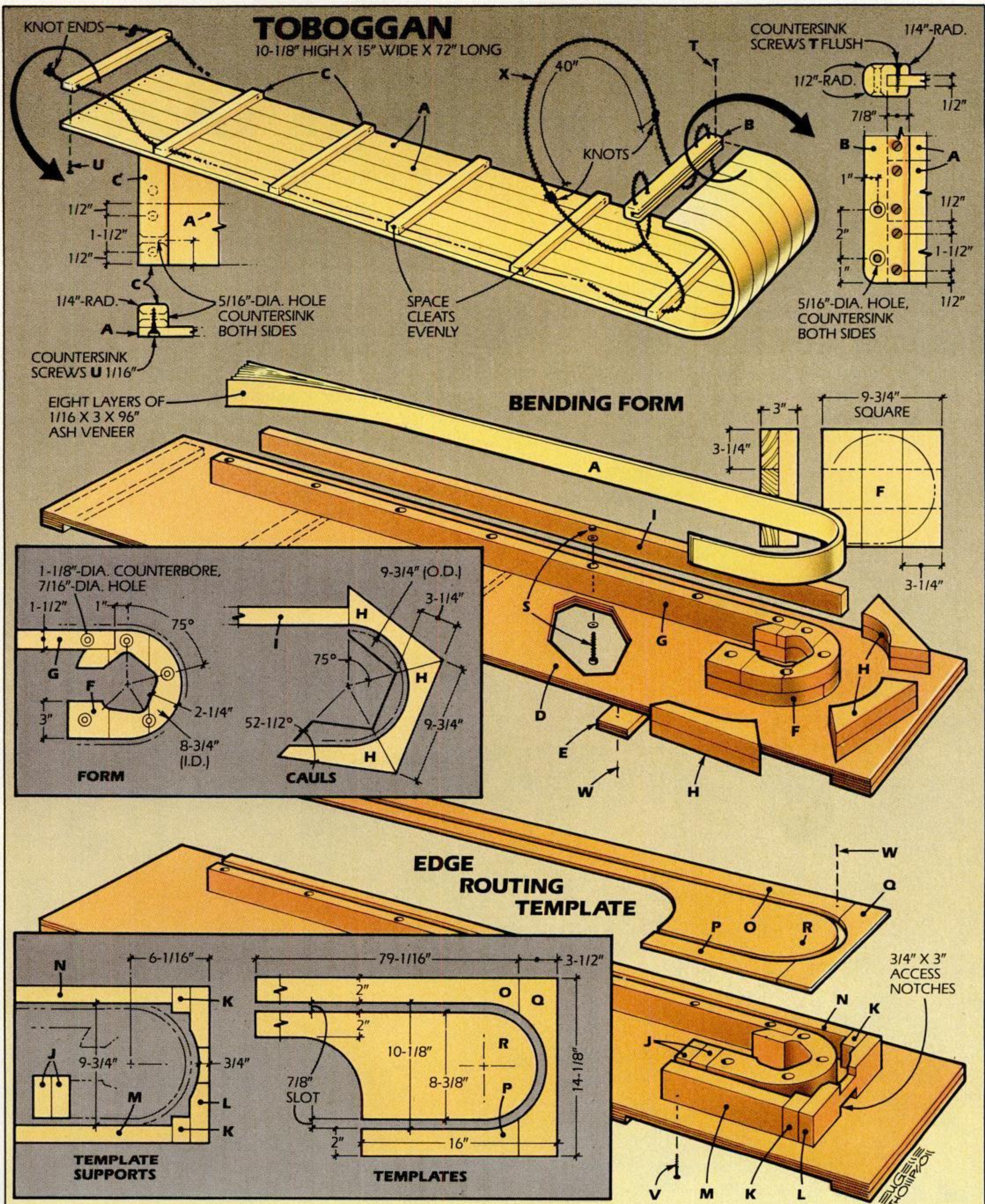
7 After spreading glue, clamp the stack at the top front caul position. Bend lamination around the form, clamping as you go.



8 With the cauls in place, check that strips are even and fully tighten clamps starting at one end and working to the other.



9 With the laminated sections completed, it only remains to trim to width and length before joining them together with cleats.



Key	No.	Size and description (use)
A*	6	1/2 x 2 1/2 x 82 1/2" ash (slats)
B	1	1 1/4 x 1 3/4 x 15" ash (nose cleat)
C	6	1 3/16 x 1 1/4 x 15" ash (cleat)
D	1	3/4 x 20 x 96" plywood (form base)
E	5	3/4 x 3 x 20" plywood (base cleat)
F**	1	3 x 9 3/4 x 9 3/4 spruce/fir (form)
G**	1	1 1/2 x 3 x 75 1/2" spruce/fir (form)
H**	3	3 x 3 1/4 x 9 3/4" spruce/fir (caul)
I**	1	1 1/2 x 3 x 76 1/2" spruce/fir (caul)
J**	2	1 1/2 x 3 x 3" spruce/fir (support)
K**	2	1 1/2 x 2 1/2 x 3" spruce/fir (support)

MATERIALS LIST—TOBOGGAN

L**	1	1 1/2 x 3 x 13 1/8" spruce/fir (support)
M**	1	1 1/2 x 3 x 12 1/2" spruce/fir (support)
N**	1	1 1/2 x 3 x 79 9/16" spruce/fir (support)
O	1	1/2 x 4 x 79 1/16" plywood (template)
P	1	1/2 x 4 x 12 1/2" plywood (template)
Q	1	1/2 x 3 1/2 x 14 1/8" plywood (template)
R	1	1/2 x 8 3/8 x 80 15/16" plywood (template)
S	11	3/8-in.-dia. x 3 1/2" hexhead bolt, washer and nut
T	12	1 1/4" No. 12 fh solid brass screw
U	72	1" No. 12 fh solid brass screw
V		1 1/2" No. 10 fh screw

W	1 1/4" finishing nail
X	18' length of 1/4"-dia. nylon rope

Misc: Plastic resin glue (5- to 6-pounds required), 120- and 220-grit sandpaper, Defthane Clear Gloss #1 Polyurethane Varnish, paste wax.
 * 8 layers of 1/16 x 3 x 96" ash veneer. Veneer available from The Wood Shed, 1807 Elmwood Ave., Buffalo, NY 14207.
 ** 2x4 stock.

CHEVY ASTRO AND

Owners report the up and down sides of two family-sized vans.

THE Astro and Aerostar vans—from traditional rivals Chevy and Ford—are bought for a variety of reasons. We asked thousands of owners how they use their vehicles and how they like them.

Chevrolet Astro Van

Chevrolet began shipping the Astro Cargo Van—the commercial version—in late 1984, but the Passenger Van didn't come along until March 1985. The idea was to let Chevy's commercial customers work out the bugs so

that Astro Passenger Van buyers could enjoy trouble-free transportation.

As it happened, some private purchasers couldn't wait for factory passenger versions to come out. Instead, they bought Cargo Vans and had them converted. Our survey reached mostly early buyers and shows that 86.5 percent did order Cargo Vans. (The mix has since swung over to about 60 percent Passenger Vans.) Of those early buyers, just over half had their Cargo Vans converted to a passenger configuration,



Chevrolet always calls its Astro (this page) a van—while Ford labels Aerostar either a van or a wagon, depending on the window and seating arrangements. Both are relatively new, part of a downsizing trend in the van market a few years ago. They represent a class of vehicle that's big enough to carry a lot of cargo and/or people—and small enough for the garage.



FORD AEROSTAR

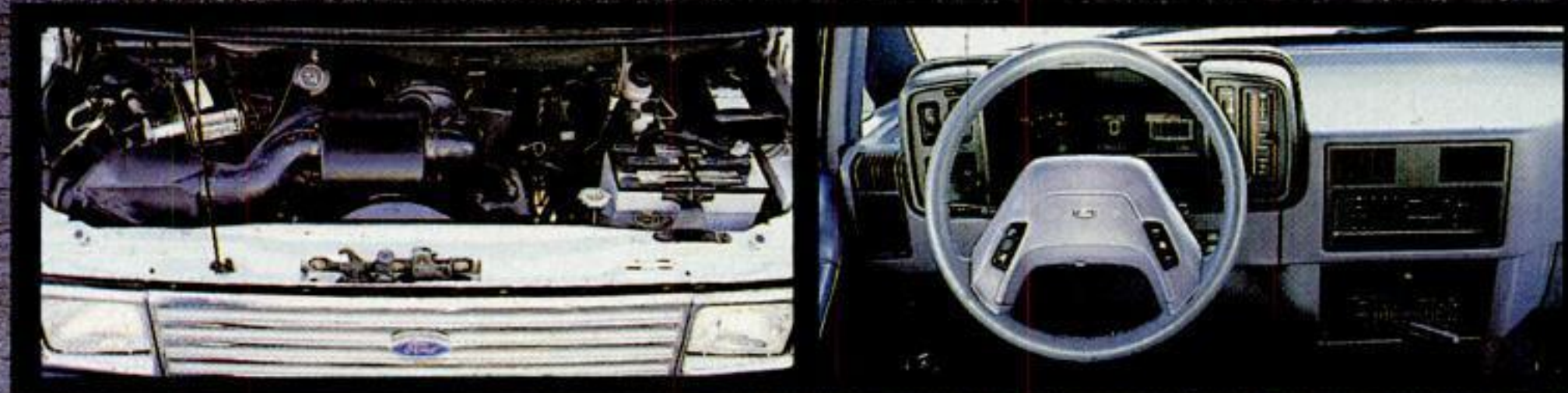
BY MICHAEL LAMM, Contributing Editor; PM Photos by Wayne Williams

either by the dealer (26.2 percent) or by outside customizers. Converted vans are different from factory jobs. A Florida retailer told us, "Almost no air flows through the Cargo Van. Vents aren't adequate, and with no windings, air conditioning is a must. The lack of insulation makes this the hottest vehicle I've ever owned." Not that opening side windows aren't available optionally. Aftermarket side windows used on conversions caused a few leaks. But then so did the standard windows. A Michigan airline captain and owner of

a CS Passenger Van wrote, "The first time it rained, the front floor got completely soaked. I've had this vehicle back to the dealer four times for correction."

An additional problem involved the hidden drip rails. A Michigan contractor said, "When you open a door, rainwater comes straight down off the roof."

Another common gripe cited the instrument panel. "The gauges are so deeply recessed," claimed a retired California mechanical engineer, "that no ambient light reaches them. I can't read the odometer or gauges in



Launched in 1985, both Astro and Aerostar initially were available with 4- and 6-cylinder engines, although Ford has dropped the underpowered 4 in '88. Engine access on either is poor at best. Astro styling is conventional, while Aerostar's "anteater" nose drew praise from owners. Astro drivers complained instruments were hard to read in poor light.

ASTRO/AEROSTAR

normal daylight. It's okay at night, when the instruments are backlit."

Nor was everyone happy with the panel switches. "The headlight switch pushes in to turn on," noted a Mississippi instructor. "It's easy to accidentally bump the switch in the daytime and not notice it. I've done this and had the battery go dead."

A few people also complained about the base-level Cargo Van's front seats and the limited legroom up front. "The standard passenger seat," said an Alabama retiree, "has no fore-aft adjustment. There's also nowhere for the driver to rest his left foot except on the wheelwell." A California electrician: "Seats are too narrow. When you turn, you fall out of them. There's nothing to hold on to." A Florida contractor was one of many who confessed, "I replaced the factory seats with aftermarket units. Makes a world of difference!" As

with windows, Chevrolet offers several upmarket seat types for all series of Astro Vans, including the base Cargo Van.

We logged the usual mumbles about lower-than-expected fuel mileage, but the Astro Van's thrift actually surprised most owners. A Montana timekeeper: "The 4.3-liter V6 gives us better than average mileage: up to 25 mpg in careful driving." And a Michigan cycle-parts dealer wrote, "We took the van from Flint to Cincinnati for a motorcycle trade show the first week we owned it. With less than 500 miles on the odometer, we averaged 24 mpg at 55 to 60 mph." EPA estimates for the base Astro with 2.5-liter Four and 4-speed is 22/26 mpg, city/highway. Most owners found the Astro Van both roomy and comfortable. "I'm amazed at how much stuff I can put inside," wrote a Tennessee leadman. "I loaded 34 50-pound bags of seed into it with no problem." However, the cargo deck apparently needs to be a foot longer to accommodate 4x8

sheets of plywood. As for comfort, this comment from a Tennessee computer operations manager was typical: "I use my Cargo Van in my business and also for everyday driving. The Astro handles great, and it has more room than I know what to do with." Handling and parking received good marks generally, but as a Michigan welder noted, "In snow, when the Astro Van isn't loaded, it's too light in the rear and has no traction." Nearly all our respondents (94.3 percent) ordered the automatic transmission. This is GM's 4-speed overdrive automatic with the lockup torque converter. A Maryland retiree observed, "The combination of the overdrive automatic and the Astro Van's aerodynamic styling results in an excellent road vehicle—very quiet." But a Wisconsin repairman countered, "Yes, we have the overdrive automatic, and it shifts hard and very late. You have to be going around 32 mph before it drops into Third

(Please turn to page 112)

CHEVROLET ASTRO OWNERS REPORTS*

Total miles driven	1,354,978	Was conversion done by dealer?	Average Range	\$11,858	No	39.1
Average miles per gallon:		No		\$8500-18,500	Dealer service opinion:	
In town/On the highway:		Yes			Excellent	19.7%
2.5-liter Four	21.6/25.1	Why did you choose the Astro?	Workmanship opinion:		Good	40.9
4.3-liter V6	17.8/22.0	Size and roominess	Excellent	24.4%	Average	23.5
4-speed manual	22.5/25.5	Styling	Good	62.2	Poor	15.9
Overdrive automatic	17.8/21.9	Economy	Average	11.1	Number of vehicles owned:	
Engine choices:		Specific likes:	Poor	2.2	This one only	26.2%
2.5-liter Four	7.9%	Handling	Comfort opinion:		Two cars	51.3
4.3-liter V6	92.1	Economy	Front seats:		Three cars	15.2
Transmission choices:		Exterior size	Excellent	34.8%	Four or more cars	7.2
Overdrive automatic	94.3%	Styling	Good	48.7	Makes of other cars owned:	
4-speed manual	5.7	Interior roominess	Average	10.2	Chevrolet	42.0%
5-speed manual	0.0	Power and performance	Poor	6.4	Ford	13.8
Option choices:		Specific dislikes:	Rear seats:		Pontiac	11.6
Power steering	96.3%	Poor paint quality	Excellent	28.8%	Dodge	9.4
Payload package	70.9	No complaints	Good	60.3	Oldsmobile	8.7
Air conditioning	64.1	Fuel mileage	Average	11.0	Would you buy an Astro again?	
27-gallon fuel tank	57.5	lower than expected	Poor	0.0	Yes	63.8%
Premium sound system	34.8	Harsh ride	Had any mechanical trouble?		Maybe	28.6
Trailer towing package	21.8	Not enough front legroom	No	57.8%	No	5.9
Model choices:		What changes would you like to see?	Yes	42.2	Would you buy another Chevy?	
Cargo Van	86.5%	No changes	What type of trouble?		Yes	63.8%
Passenger (base) Van	7.0	Better paint	Electrical system	16.7%	Maybe	30.3
CS Passenger Van	3.8	Better fuel mileage	Misc. transmission problems	15.4	No	5.9
CL Passenger Van	2.7	Better instrument visibility	Brakes	11.5	Age distribution of owners:	
Has your van been RV-converted?		More front legroom	Air conditioner	10.3	Under 29 years	13.9%
Yes	52.5%	Greater body length	Power steering system	9.0	30-49 years	59.9
No	47.5	How much did you pay?	Dealer repairs satisfactory?		50-plus	26.1
		Average	Yes	60.9%		

FORD AEROSTAR OWNERS REPORTS*

Total miles driven	1,423,665	Comfort	12.6	Average	3.0	Good	46.4
Average miles per gallon:		Handling	11.4	Poor	1.5	Average	16.4
In town/On the highway:		Price	11.4	Comfort opinion:		Poor	13.5
2.3-liter Four	22.6/27.0	Specific likes:		Front seats:		Number of vehicles owned:	
2.8-liter V6	16.6/21.3	Comfort	45.8%	Excellent	66.3%	This one only	27.0%
5-speed manual	19.6/24.2	Handling	40.6	Good	29.3	Two cars	49.6
3-speed automatic	16.3/21.1	Roominess	39.3	Average	3.2	Three cars	17.3
Engine choices:		Styling	37.7	Poor	1.2	Four or more cars	6.1
2.3-liter Four	7.9%	Ride	24.7	Rear seats:		Makes of other cars owned:	
2.8-liter V6	92.1	Specific dislikes:		Excellent	39.8%	Ford	48.2%
Transmission choices:		Fuel mileage		Good	49.1	Chevrolet	20.1
3-speed automatic	77.5%	lower than expected	24.0%	Average	9.9	Mercury	7.2
5-speed manual	22.5	Spare tire location	12.2	Poor	1.2	Oldsmobile	6.4
Series choices:		No complaints	9.6	Had any mechanical trouble?		Nissan/Datsun	6.0
Aerostar (standard)	18.8%	Noises and rattles	7.4	No	64.0%	Toyota	6.0
Aerostar XL	36.9	Glovebox too small	7.0	Yes	36.0	Would you buy an Aerostar again?	
Aerostar XLT	44.3	Move shifter to column	6.3	What type of trouble?		Yes	63.3%
Has your van been RV-converted?		What changes would you like to see?		Electrical system	16.7%	Maybe	28.3
No	83.0%	No changes	15.9%	Misc. transmission problems	14.2	No	8.4
Yes	17.0	Better fuel mileage	12.0	Noisy brakes	13.3	Would you buy another Ford?	
Was conversion done by dealer?		Full-sized spare tire	10.2	Heater	13.3	Yes	69.4%
No	65.7%	Bigger glovebox	6.0	Ignition switch	7.5	Maybe	26.4
Yes	34.3	More horsepower	5.7	Windshield wipers	6.7	No	4.2
Why did you choose the Aerostar?		How much did you pay?		Dealer repairs satisfactory?		Age distribution of owners:	
Styling	41.6%	Average	\$13,228	Yes	56.8%	Under 29 years	10.3%
Roominess	41.3	Range	\$8998-17,000	No	43.2	30-49 years	62.4
Size	14.5	Workmanship opinion:		Excellent	23.7%	50-plus	27.4
		Excellent	45.1%				
		Good	50.4				

*Percentages might not equal 100% due to rounding or an insufficient amount of data.

SPECIAL REPORT

STEREO '88

COMPONENTS THAT BRING YOU CLOSER TO THE MUSIC



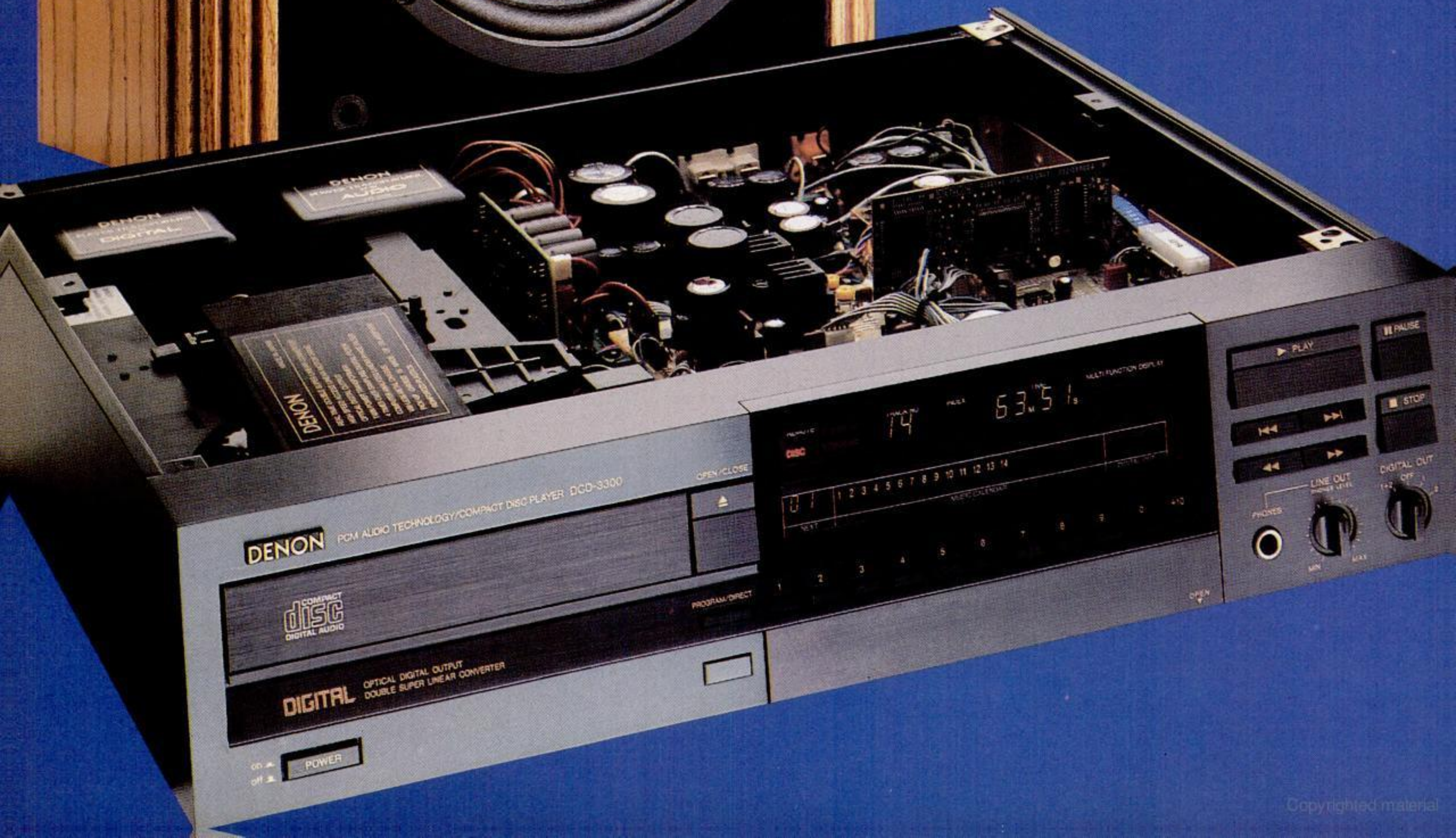
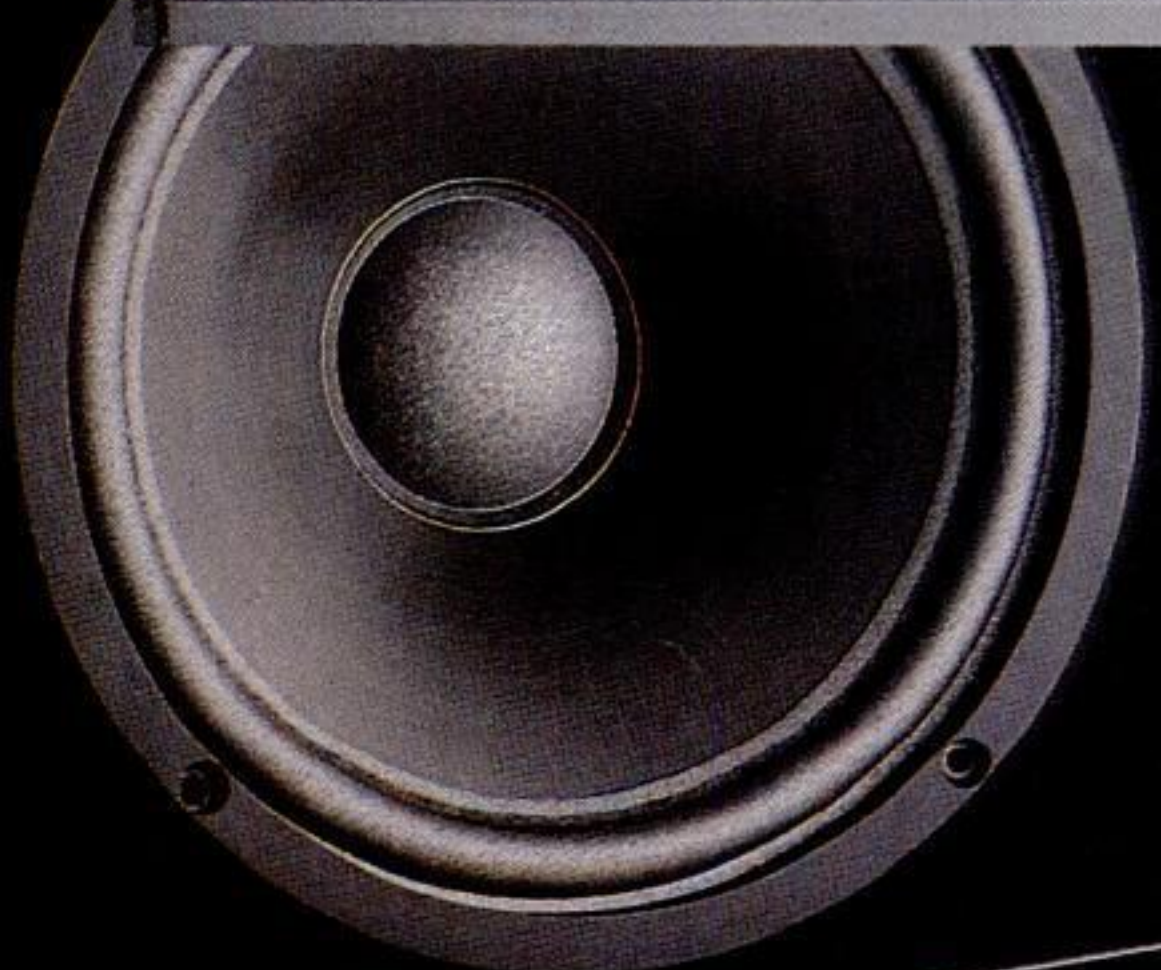
- **COMPACT DISC PLAYERS:**
What's Under The Hood?
- **AMPLIFIERS:**
Horsepower On Demand
- **LOUDSPEAKERS:**
Black Magic Meets
Big Science



Lineage PA200 amp (\$1650), designed by John Curl and hi-fi pioneer Saul Marantz, delivers 100 watts per channel — enough to handle digital signal from Sony CDP-705ES compact disc player (\$1500) and drive Magnat's Magnasphere Beta tower speakers (\$1790).



Sansui INTEGRATED AMPLIFIER AU-X901



DENON

PCM AUDIO TECHNOLOGY/COMPACT DISC PLAYER DCD-3300

compact disc DIGITAL AUDIO

DIGITAL

OPTICAL DIGITAL OUTPUT DOUBLE SUPER LINEAR CONVERTER



WHAT'S COMING IN HOME STEREO

Hi-fi's getting back to basics, where performance wins out over grilles and frills.

BY
STEPHEN A.
BOOTH,
Electronics Editor

There's a lot under the hood of Denon's DCD-3300 compact disc player (\$1600). Note the separate power supplies for its digital and analog sections. The CD player feeds Sansui's Vintage AU-X901 integrated amp (\$1100), whose 130 watts per channel drive Infinity's new Reference Standard 6-Kappa loudspeakers.

WHAT we call "hi-fi" had its beginnings about half a century ago, when a music lover named Avery Fisher sought to build a better radio-phonograph console, one that would reproduce recorded music with greater fidelity to the original performance.

Indeed, all the founding fathers of hi-fi were music lovers who strove to build that better mousetrap. Ex-Navy radioman Saul Marantz tinkered with amplifiers to make them more accurate. John Koss took the headphone from the radio shack to the living room. Edgar Villchur, founder of Acoustic Research, fine-tuned the dynamic loudspeaker from a public-address system to a music instrument. So did Paul Klipsch and other hands-on music aficionados too numerous to mention.

Much of the refinement and innovation of home music systems today emerges from large corporate labs, making the achievement difficult to attribute to any one individual. Nonetheless, the goal of high-fidelity sound equipment remains the same. The magic black boxes and the music recordings themselves are designed to re-create, as authentically as possible, the nuance and the detail of the original performance—whether it was recorded in the presence of a paying audience or team of paid studio engineers.

This goal is elusive, on two counts. Firstly, it requires us, the listeners, to suspend our disbelief, to imagine for a moment that we are present physically at the site of the actual performance, accessible to the many and varied sensations of the moment instead of confined to the familiar surroundings of our listening rooms. Such jumps in time and space do not come easy for most mortals: That they succeed so often in helping us make the leap says all the more of a great novel, or painting, or even a music recording and playback system.

The other obstacle to replicating the musical performance is the reproduction equipment itself. As good as it might be—and it gets better all the time—the hardware will somehow or other alter the performance, either by adding something that was never there or subtracting something that was. It is a bit like the difference between watching a baseball game on TV and actually viewing it in the park. At the stadium, you can take in everything that's

happening as it happens. And what your eyes see is in its natural perspective. On the tube, what you see and when is determined by the camera, which might shift focus selectively. The lens itself distorts reality, making distances appear greater or shorter than they are, denying you the 3-dimensional perspective needed to judge the trajectory of the ball.

Fortunately, the problem presented by hi-fi equipment is more easily overcome than the mind's unwillingness to suspend disbelief.

When hi-fi gear adds something to the music, it is usually mechanically or electrically induced distortion. We mean distortion in the broadest sense: either tonal coloration caused by resonance in a speaker's wooden cabinet, or hum and hiss attributable to electrical noise or the surface material of a record. When hi-fi gear subtracts something, it is usually the ambience of the actual performance. Since restoring this would require eliminating the boundaries of the listening room, hi-fi designers have confined themselves to eliminating artifacts the equipment creates.

In the mechanical arena, hi-fi designers often find themselves battling inertia. One good example is loudspeaker cones and the voice coils that drive them. New materials are now employed that are stiff yet compliant, light enough and fast enough to keep in step with the music's dynamics. Another problem of inertia, the tracking of a stylus in a record groove, is circumvented by the development of the compact disc player that reads the musical information with a weightless beam of laser light. Though it might arrive a day late and a buck short, a conventional record turntable that reads grooves with a laser instead of a needle is now under development.

In the realm of electronics, each year brings quieter, faster-acting circuits, more accurate filters, amplifiers that can respond and respond quickly to the need for a sudden spurt of power. On the horizon, the new breed of superconducting materials holds great promise for fast, powerful amps in particular and all electronic circuits in general. High-fidelity's come a long way in the past 50 years. Perfection might never be attainable, hi-fi's alchemists might never find their Philosopher's Stone, but they're getting close. **PM**



COMPACT
DISC PLAYERS:THE SOUNDS
OF SILENCE

Contrary to hype and myth, all compact disc players are not created equal. Components and construction can make the difference.

BY
FRANK VIZARD,
Contributing Editor

Vibration-damping materials are used in the laser transport mechanism of Denon's DCD-3300 compact disc player (\$1600, foreground). It shares oversampling, dual digital-to-analog converters and other high-performance features with Sony's CDP-705ES (\$1500), Yamaha's CDX-1100U (\$1100) and Magnavox's CDB650 (\$500).

"MOTOR oil is motor oil," growls the skeptic in the TV commercial. By the same token, some folks would have you believe that all compact disc players are the same. What then accounts for price tags as high as \$3000 and as low as \$200—even lower on sale days?

Remote control, advanced programmability and other convenience features that have nothing to do with sound contribute to some of the differences in price. But the fact remains that the character of a CD player's sound is determined by its internal components and construction. All CD players sound very, very good—much better than the average LP turntable. But some CD players sound better than others, and this will be evident if you're a critical listener and have your player connected to a good amp and loudspeaker system.

When you're shopping for a CD player, you'll encounter a lot of jargon and not a little hype. In the hype department are buzzwords, such as "triple-beam laser," seeming to imply that it's better than a single-beam pickup, although no audible difference has ever been demonstrated. It's just that manufacturer's way of building the machine, and not necessarily better than another method. The elements that do contribute to audible differences in a CD player include sampling rate and filters, digital-to-analog converters, laser tracking and suspension, electrical isolation and shielding, and finally, the digital player's analog output stage. Here's what they do and what to look for.

Generally, the degree of sampling the player performs on the disc determines the type of filtering found in the machine.

To construct the digital signal that is placed on a compact disc, music is sampled 44,100 times per second (44.1 kilohertz, or 44.1kHz). In playback, the most basic CD machines sample the disc at the same rate. For greater accuracy, some players double- or quadruple-check the data on the disc. This is called oversampling (at 88.2kHz and at 176.4kHz). But because the upper limit of human hearing is 20kHz, all CD players must filter out signals above this frequency.

CD players that do not oversample use analog filters to eliminate the signals beyond the audible range. Unfortunately, analog filters

are sometimes inaccurate. If they inadvertently block out sounds below 20kHz, some treble information will be lost. Compared to an LP record, the music might not sound bad, but it won't sound as good as a CD should.

CD players that oversample use the more-consistent digital filters to supplement their analog filters. The combination will hush up any signal above 20kHz, but some digital filters are more effective than others. Where one digital filter might suppress sounds above 20kHz by 50 db, a better filter will suppress them by 80 db. The higher the number, the better.

A digital-to-analog (D/A) converter turns numbers into soundwaves, or codes into music. Every CD player has at least one. The better units boast two.

With only a single converter, a CD player must first decode one part of the digital information (for example, the left channel of the stereo signal) before another. What happens then is the left channel sound arrives at your ears slightly ahead of the right, instead of simultaneously. This slight shift in timing might not be heard so much as it can be sensed as an imbalance of the stereo image. With two converters—one for each channel—the whole stereo image emerges in sync.

Most D/A converters now used in CD players are 16-bit models. Basically, this means a slice of sampled music can be expressed by a number no more than 16 digits long. If more digits were available, the music could be coded and decoded even more accurately. That day will come: 18-bit D/A converters are under development now. In the meantime, companies such as Yamaha and Denon design their current players to perform, under some circumstances, like higher-sampling machines.

Laser tracking, suspension materials and error correction are intimately related.

An error on a CD might be caused by a flaw in the disc, but the way the problem is solved depends on the machine. Errors occur when digital information can't be retrieved, or when the laser pickup can't track the sequence.

Most CD players restore missing information very well. If the missing piece is small, they just guess what the sound would be by interpolating between the sounds that come

SOUNDS OF SILENCE

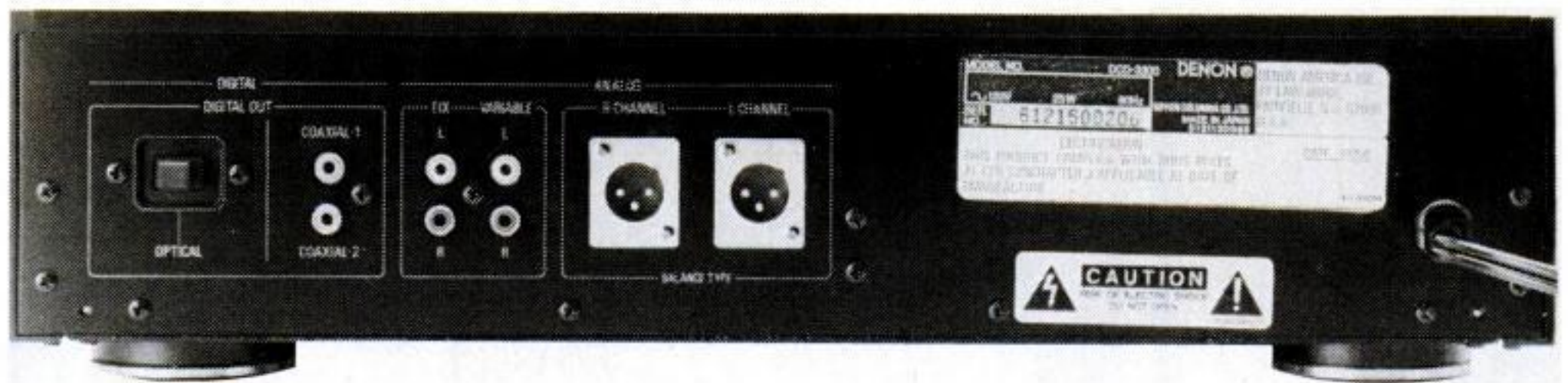
before and after the glitch. If the amount of missing data is too great, the player will go silent for a moment or two—or even shut down in an extreme case—rather than produce jibberish.

Laser tracking errors can be caused by external vibrations, and if the shock is extreme, the laser will skip the way an old-time needle could get knocked out of the groove. To prevent this, manufacturers build a lot of resiliency into the transport mechanisms that carry their laser pickups. This usually means the pickup has an independent suspension to isolate it from the main chassis. Moreover, the servomechanism and perhaps the chassis itself are increasingly fashioned from antiresonant or resonance-damping materials. Sony, for example, uses a compound called Cerasin. For the record, a “3-beam” or “triple-beam” laser doesn’t give triple the pickup power of a “single beam” as the term might imply. It only means that the beam of light is split—outrigger style—to help the laser track. It’s just one way of building a pickup-transport system and it’s not necessarily better than any other.

Distortion-inducing electrical noise exists within any CD player, caused by power supplies, front-panel controls and even the digital processor itself.

To prevent the sound distortion that occurs when interference from one internal component spreads to another, many of today’s top quality CD players have heavy, expensive metal shielding to separate power supplies, digital processors, analog sections and even the noisy LED displays and electronic controls on their front panels. The best CD players also employ separate power supplies for their digital and analog sections. Some even use noise-free fiberoptic linkages between the digital and analog stages instead of conventional wiring that might transmit noise.

The analog output stage of a CD player is its link to the hi-fi system. Some are better than others. When you shop, look for the lowest distortion rating possible, as you would with an amp or preamp. Outside the player, on its back panel, you’ll see the actual output jacks. Gold



Denon's DCD-3300 compact disc player has Cannon-type balanced output jacks for quiet, direct connection to an amp. Inputs of amp must be balanced, too, for full advantage.

plating provides better electrical conductance. Increasingly, top-flight players offer “balanced” analog outputs, a feature borrowed from pro-sound gear. It reduces the pickup of stray noise even further, and also permits the CD player to bypass an amp’s preamp stage and go directly to amplification. (The balanced output has no use unless your amp has balanced inputs.) Increasingly, some CD players sport digital output jacks, which enable you to bypass the internal D/A converters and use an outboard digital processor that presumably has better performance than the players built-in circuits.

While differences in construction and internal circuitry go a long way toward explaining differences in price, the variety of convenience features offered on CD players also affect the cost.

Basic features include track number and elapsed time information. Some degree of track-programmability is also common, and the more expensive machines offer the most flexibility.

Programmability reaches its zenith in players referred to as “CD changers.” You load discs into a magazine which is then inserted into the player. This gives you the liberty of accessing any track on any disc contained in the magazine. Prices for CD changers vary according to their disc capacity—five to 10—and the availability of secondary features. Pioneer, for example, offers a lineup of changer models that all hold six discs but range in price from \$375 to \$800.

An alternative to the magazine design is the disc carousel changer, Sony’s CDP-C5F, listing for \$450. Hitachi offers a dual-tray model, the DAW-300SW (\$299) that offers continuous playback from one disc to the other.

The degree to which you can access a disc’s track is another point

of distinction among players. The most sophisticated players can read the index code contained on some discs, information particularly prevalent on classical music recordings, where individual tracks are divided into subsections so that specific portions of a long musical work can be accessed quickly. CD players invariably allow you to move forward or backward through a selection, with better models offering audible cues to your position on the track.

Other features adding to the cost of a CD player appear on the back panel. These may include an output-level control, which allows you to match the volume level of the CD player to the loudness level of other audio components. This way, you’ll avoid the abrupt volume changes when switching from one music source to another. Another optional feature is the CD-subcode output, for the anticipated arrival of discs carrying still-video images or song lyrics.

Individual companies, of course, often offer features hard to find among competitive products. For example, the DX5 (\$699) from dbx offers three signal processing circuits that can be bypassed, if desired. One circuit is called Digital Audio Impact Recovery and it is designed to add impact to musical transients. An ambience control can be used to increase or decrease stereo separation and spaciousness. A compression circuit reduces dynamic range to a level more suitable for background listening, and easier dubbing onto cassette.

Home tapers might also appreciate a feature offered on Bang & Olufsen’s 5500 CD player (\$999). Spacing intervals can be programmed into the disc’s playback sequence so that the music search systems in cassette decks can later find individual selections more easily.

Audio manufacturers make CD players that offer differing combinations of convenience features and technical advantages. Convenience might or might not be worth paying for, depending on your preference. But top quality sound is always a good investment. Even if your CD player costs more than the hi-fi components it’s now connected to, it will help them sound better—and you’ll have a worthy source unit waiting in the wings should you upgrade amps and speakers in the future. **FM**



Onkyo's DX-C600 changer (\$600) holds six compact discs, and has noise-free fiberoptic coupling between digital and analog stages. Remote control (right) is a bonus.

THE STRIKING NEW COBRAS

**Designed
without the coil, or the hisssss!**

The new Cobra cordless phones are unlike anything you've seen or heard before.

With sleek, European styles and colors. Plus curved, comfortable handsets.

And terrific features. Like digital security coding and exclusive Clear Call Circuitry, for maximum performance and clear voice reproduction.

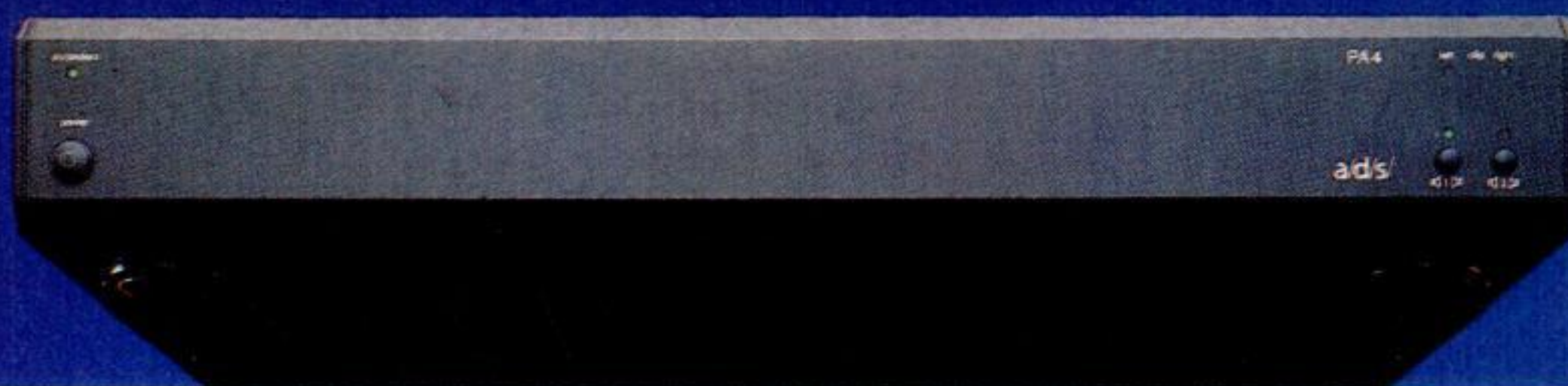
Plus lots of exclusive new user-friendly features. Like a hold button that's accessible from the handset or base. A 3-position volume control to amplify callers' voices. And Cobra's great room monitor feature.

Look for Cobra's great line of stylish cordless phones. Plus Cobra's beautiful new corded phones and answering systems. For the dealer nearest you, dial 1-800-COBRA 22.

See the Cobras people love to handle.



Cobra
DYNASCAN CORPORATION



AMPLIFIERS:

THE DRIVING FORCE

Digital sources place tough demands on an amplifier. What you need is lots of clean, quiet-running horsepower.

BY
DAVID LANDER

A massive power transformer helps Sansul's Vintage Series AU-X901 integrated amp (\$1100, foreground) generate 130 watts per channel. Luxman's 80 watts per channel LV-105U Brid (\$900) is an integrated amp that combines vacuum tubes and solid-state circuitry. The PA4 integrated amp from ADS (\$1100) has 150 watts a side plus an indicator light for clipping distortion. Like Harman/Kardon's 90 watts per channel PM655-VXI integrated amp (\$600), it offers variable output settings for optimal speaker performance.

LISTENING to a CD or other digital audio program source is like driving a car in the fast lane of a German *Autobahn*, where there is no speed limit: Without sufficient power at your disposal, the experience won't be very pleasurable.

Because digital program material can be expected to have a dynamic range at least 10 db greater than a comparable analog recording, amplifier power theoretically should be increased tenfold. In reality, though, amplifiers usually loaf along at a fraction of their rated power. The dynamic peaks of a CD would crack grandmother's china if you cranked your volume controls to the highest setting.

So, how much power do you need? Unfortunately, assessing amplifier power is a complicated matter. Since it can be measured in many ways, there's more to look for than a single number.

The Federal Trade Commission has long been aware of this fact, and in 1975 stepped in to halt the abuses of companies that wanted you to think your amp could launch a speaker into orbit.

Since then, all published power specs have to state continuous power in watts and be accompanied by a bandwidth figure as well as a maximum distortion level. The wattage figure, followed by the letters RMS (for root mean square) or the phrase "Continuous Power," refers to the average amount of power the amp is capable of producing over an extended period of time. The wattage figure is followed by a frequency bandwidth range. The best of these is from 20 to 20,000 Hz, the accepted range of human hearing, and means the amp is capable of delivering its rated power even when program material contains low bass, which is more demanding of the unit's power supply. Finally, the spec should contain the resistance (8 ohms being the norm) and a qualification such as "with no more than 0.5 percent THD." The abbreviation stands for total harmonic distortion, and the lower the percentage, the better. Look at each of these numbers carefully. Some lower-priced receivers, for example, measure power from 40 Hz rather than 20, which means they lack the punch needed to reproduce the lowest bass notes with less than rated distortion.

The FTC spec ensures that you're comparing apples to apples when you shop for an amp—at least as far as a unit's continuous or average power rating is concerned.

Scaling the peaks

In the digital age, however, another kind of power has become increasingly important. This is known as dynamic headroom and describes an amplifier's capacity to track the instantaneous peaks—such as a piano key struck forcefully or sudden drumbeat—that so many compact discs contain. The FTC does not require manufacturers to publish this spec, though many do.

In testing for continuous power, a steady sine wave is fed into an amplifier for a minimum of 5 minutes. The dynamic headroom test is done with a signal that, every 1/2 second, contains a +20-db spike, 20 milliseconds (1/50 of a second) in duration. This is fed into the amp, and its maximum output voltage before the clipping point (the level where it actually severs the rounded peaks from the sine wave, visible on an oscilloscope) is recorded.

Dynamic headroom is the ratio of an amplifier's peak-handling power to its continuous power. But instead of stating the spec as a ratio, it is converted to decibels by a mathematical formula. For example, a unit rated at 50 watts RMS and measuring 200 watts on the headroom test has a peak to continuous ratio of 4:1. To convert this to decibels, you must find the *common logarithm* of four and multiply it by 10. A logarithmic table, or a calculator, will tell you that 0.6 is the common log of four. This, multiplied by 10, says the amp has 6 db of dynamic headroom.

The more dynamic headroom an amplifier has, the better. Yet many audio experts are quick to point out that headroom on its own is not enough.

This faction argues that musical peaks are not limited to durations of only 1/50 of a second, and that they may overlap on the program material. In such instances, it is the amp's capacity for producing longer term "continuous" power that counts. But to squeeze an additional 3 db in dynamic capability from an amplifier, its power must be doubled. Therefore, while upgrading from 50 to 100 watts is meaningful,

DRIVING FORCE

going from 80 to 100 isn't. There is no simple formula that can tell you just how much wattage you need. An amp must produce enough power to drive the cones of a loudspeaker that translate electrical signals back into sound waves. But speakers vary widely in sensitivity, with some less efficient designs demanding far more power than others to convert the same amount of electrical energy to acoustic power.

The size and acoustical properties of your listening environment also are a factor: A heavily furnished room will absorb more sound waves than a sparsely decorated one, and therefore, will require greater power to sustain an audible volume level. Ultimately, you'll have to trust your ears. The wattage is whatever produces distortion-free sound at your preferred volume.

Distortion might be attributable to one or more components of a hi-fi system, but clipping distortion is definitely a product of the amplifier. If you're in the market for a new amp, you should listen for clipping on musical peaks and high-volume passages. The sound may be just a bit fuzzy or very strident. It could buzz, sound akin to shattering glass or even like knuckles rapped sharply against a wall. To aid the ears of listeners, some amplifiers (such as the PA200 from Lineage and the PA4 from ADS) have clipping indicators, a highly useful feature.

The most devout audiophiles hold that amplifiers sound very different from one another. In their fervent praise—or vilification—of various esoteric power amp designs, they often sound like wine critics in a chateau cellar. They might describe a particular amplifier's sound as "spacious" or "airy," call its bass either tight or lacking in solidity,



Kenwood's KA-880D integrated amp (top, \$410) and Sansui's Vintage AU-X901 (above, \$1100) boast multiple inputs and outputs on their back panels, including balanced Cannon jacks.

and insist that midrange tones are clearly or inadequately defined. One long-standing argument among audiophiles pits amplifiers that use vacuum tubes against their solid-state brethren. Proponents of the tube amp claim it has a more musical sound, but they pay a double premium for this perception. Tube amps are extremely expensive. And tubes, like batteries, deteriorate in performance over time and must be replaced. One manufacturer, Luxman, combines tubes and transistors in its "Brid" (as in hybrid) amps to exploit the best features of each.

Whatever the audiophile cultists purport to hear, the one thing that should not be audible in an amplifier is noise—whether hum or hiss.

Most of the recognized demons of am-

plifier circuitry have already been slain. THD, for example, has been reduced to the hundredths of a percent range—though experts argue that no human being can hear harmonic distortion below 0.5 percent. But superquiet digital sources lack background noise, so any noise in the amp will be more evident. For this reason, some manufacturers (such as Sansui, Kenwood, Denon) build so-called "balanced" inputs on the back panels of their amps (as well as balanced outputs on their CD players), in addition to the conventional RCA-type jacks. Basically, the more expensive Cannon-type connectors used for these inputs reject electromagnetic and radio frequency noise.

Once the issues of power and dynamic headroom are solved, you can concentrate on other important criteria, such as whether you want a separate preamp and power amp, or an integrated amp (where both are combined in a single enclosure), or a receiver (which adds a radio tuner to the mix). If you want to interconnect your hi-fi and video systems, be sure the amp has proper jacks.

Usually, separate preamp-amp-tuner combinations tend to be costly. Integrated amps are ideal if you prefer discs and tapes to FM, since you'd be wasting that part of a receiver's price allotted to the tuner section. On the other hand, FM listeners in areas plagued by poor reception might want the performance found only in a separate tuner, and pair it with an integrated amp.

If you find a receiver can meet all your needs, buy one. Many high-quality models are available today, and mounting preamp, amp and tuner on a single chassis means a lower price tag. **FM**



Pioneer's Elite A-91D amp (\$1500) has dual, built-in converters to process digital signals directly.

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LOUDSPEAKERS:

T TRANSPARENT IMAGES

Speakers shouldn't intrude between the listener and the music. Computer-design and exotic materials make them more transparent than ever.

BY
ROBERT ANGUS

Intricate crossover network of Analog & Digital System's CM-7 loudspeaker (\$1350, foreground) routes bass, treble and midrange frequencies to the appropriate driver cone. Spherical modules atop Magnat's Magnasphere Beta speaker (\$1790) are designed to disperse sound in an omnidirectional pattern. Soundfield Model 100 by dbx (\$899) has a computer-designed driver array that provides a full stereo image anywhere in a room. The Bose Model (\$600) achieves a similar effect.

ALL the fears were unfounded. Speaker cones didn't rip apart and voice coils didn't melt. Older loudspeakers just sounded better when compact discs were played—their true potential never having been exploited.

The extraordinary dynamic range and frequency response of the digital medium opened audiophiles' ears. At the same time, loudspeaker designers learned that CD and other digital sound sources present new challenges and new opportunities. As a result, there have been some significant changes in the way loudspeakers are designed and built. Most of these, the designers admit, would have occurred whether digital came to exist or not, because they result in better speaker design for reproducing any kind of music. The truth of the matter is that, whether the storage medium is digital or analog, the signal which reaches the loudspeaker is still analog.

One of the great myths about loudspeaker design and manufacture is that it's a black art. It may have been once, but in the 1960s, science intruded on magic in the form of anechoic chambers, extensive test measurements and computerized listening panels. The 1980s have brought even more sophisticated measurement techniques including holography, laser vibration interferometry, Fourier analysis and other approaches both costly and undreamed of by designers of another era.

The appearance of these tools coincides with the coming of age of digital sound. They augment—not replace—the black art of the designers' craft by predicting what changes in sound will occur with the substitution of new materials, new shapes or different crossover points. They save thousands of hours of mathematical computations by showing exactly what happens to the surface of the loudspeaker cone under any particular set of circumstances. Regardless of what the measurements might show, it's still the trained ear that serves as the final arbiter. This is why Bose Corp., which has access to some of the most expensive and most sophisticated test equipment in the country, still spends thousands of dollars yearly on concert tickets for its engineering staff.

No high-fidelity component has undergone less change over the past 60 years than the

dynamic loudspeaker. It still consists of a cone, made mainly of paper, that is mounted in a basket and pushed back and forth by an electromagnet. After some flirtation with such exotic materials as beryllium and titanium, most speaker makers seem to have returned to tried-and-true paper cones—although nowadays they might be molded from or reinforced with various resins, carbon fibers or other plastics compounds to make them lightweight as well as compliant. The composite woofer in Infinity's RS-6 Kappa speaker is one example.

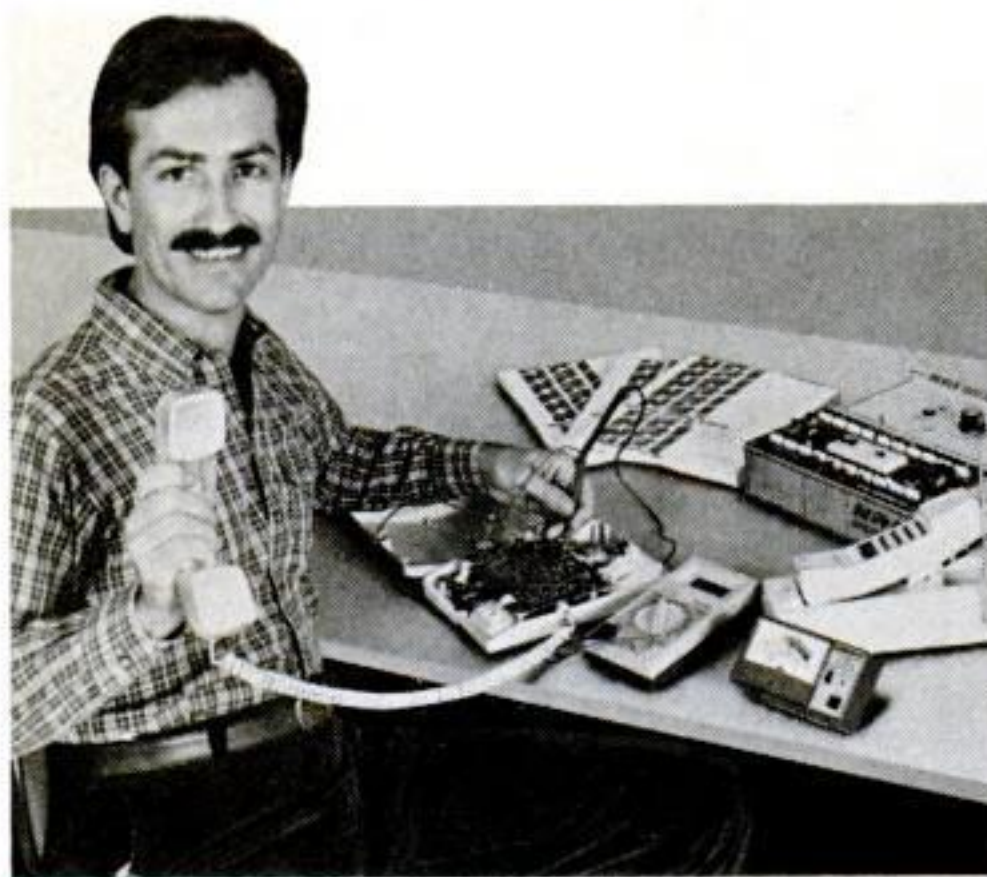
Perhaps the most significant change in drivers has taken place in voice coil assemblies. They're longer than they used to be. Most manufacturers now use some form of "flat" (or at least not round) copper wire in the windings. Additionally, there's ferrofluid or some other form of coolant to dissipate the heat which builds up. The name of the game here is to boost power-handling capacity and efficiency in order to cope with digital's greater dynamic range and extended bass response.

Tightly wound, small-mil copper wire has been used for speaker coils since their introduction in the 1920s. The idea of using rectangular wire in order to pack as much copper into the magnet gap as possible is more recent, as is the idea of lengthening the coil itself. Both enable the speaker magnet to transfer more energy to the speaker cone. There is greater control over the movement of the voice coil as well. This lets the speaker convert more amplifier energy into sound (speaker efficiency). It also enables the speaker to handle musical transients better, to respond quickly to tiny impulses the way tight steering and a taut suspension help a car hold the road.

To prevent the thin copper ribbon from melting during prolonged surges of high energy, most manufacturers now use some form of cooling fluid or paste to dissipate heat. In fact, although the surges of power produced by sudden musical climaxes (particularly in the higher frequencies) in a digital recording are usually much greater than those encountered on compressed analog recordings, they also tend to be of shorter duration. Thus, there is less chance of a voice coil melting under the onslaught of a digital signal.

Sound quality is more than just a matter of

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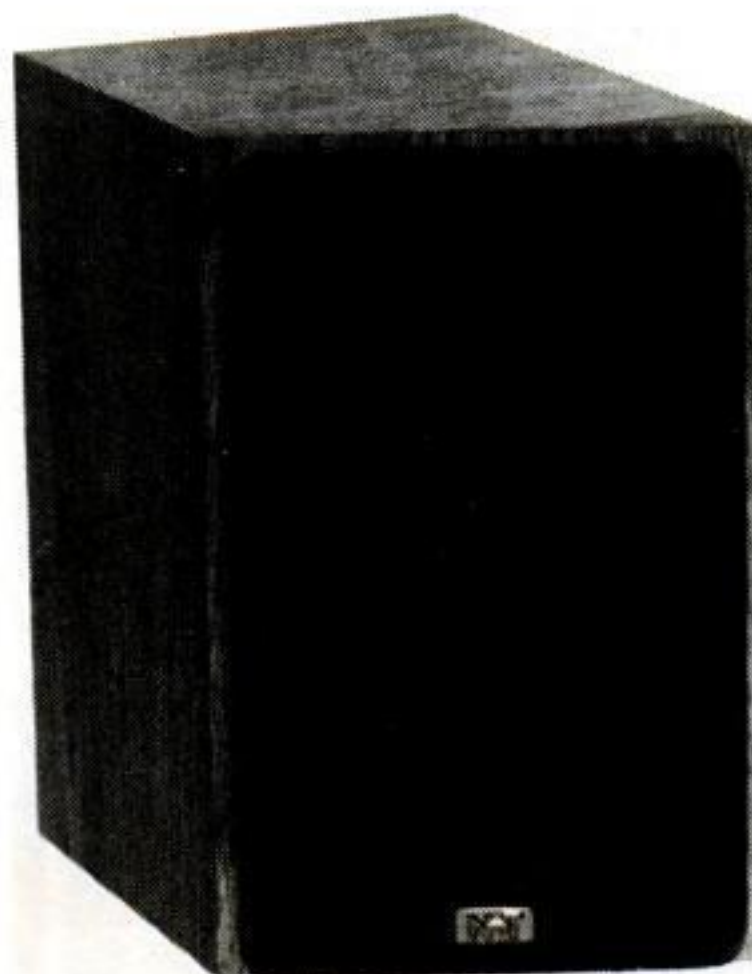
LOUDSPEAKERS

how good the elements are inside the speaker enclosure. It also depends on the design of the enclosure itself and the arrangement of bass woofers, midrange reproducers and treble tweeters.

The same measurement techniques and computer projections which provide greater durability and power-handling capacity in drivers also help to design speaker enclosures. The goal of any speaker design is transparency: The speaker itself must not resonate and thereby add any coloration to the sound. To prevent this, some manufacturers are replacing wooden enclosures with new, antiresonant materials (such as the heavy metal-impregnated polymer used by ADS) and abandoning the rectangular box and other parallelograms for asymmetrical enclosures that inhibit internal standing-waves.

Besides enclosure design, the latest measurement techniques help to position the driver elements inside to provide better imaging, a broader stereo field within the listening room and life-like, 3-dimensional sound. Notable among recent innovations is the "sound-field" technique pioneered by dbx, which tailors high-frequency dispersion for stereo anywhere in the room.

Although computer modeling and other design-aids make the loudspeaker a more precise instrument than ever before, much of the work is still done by ear and all of it is checked by educated ears (some leading companies employ musicians for critical auditioning). But what does this mean to you when you're shopping for loudspeakers? About the same as it did in the days before digital. The same criteria apply today as a decade ago: A bigger box or more expensive box doesn't necessarily mean better sound. Four speaker cones inside aren't necessarily better than two. You're going to have to audition for yourself, using the same test instruments the experts use: your own ears.



Angled panel of NHT Model I bookshelf speakers (\$299) permits flexibility.

STEREO '88



TSW-810 speakers (\$850 each) by Acoustic Research use polypropylene cones.

You can narrow your search by looking for models in your price range that boast reasonable efficiency, adequate power-handling ability, and the most accurate frequency response over the widest possible range of frequencies. Let's tackle these one by one.

A speaker's efficiency denotes how well it uses amplifier power to generate sound pressure levels (SPL), measured in decibels (db). The higher the SPL the better, with measurements in the 90-db range quite typical.

Power handling tells you the minimum amplifier input the speaker requires to generate sound, and the maximum it can accept before distortion and potential damage occur. Be sure your amp has enough power to drive the speakers you buy, but not more than they can handle.

Frequency response tells you the range of sounds the speaker will reproduce, and how accurately. The range is expressed in Hertz (Hz), and since 20 to 20,000 is the accepted range of human hearing, you should look for speakers that reach closest to those extremes, or exceed them. Accuracy, expressed in decibels, denotes how exactly the speaker reproduces the entire range of frequencies or any specific frequency. Any deviation—overall or at a specific frequency—should be within 3 db.

When you go to the store, bring a recording (preferably digital) you know well. Listen for extended bass, better treble definition and wide dynamic range that should be clean and undistorted. Check speaker imaging by listening from different spots to see whether the optimum stereo-listening position is a small area midway between the speakers, or whether it extends more or less evenly around the room. Select whatever sounds best within your budget. The beauty and the exasperation of shopping for loudspeakers is that there's so much to choose from. And these days, so much of it is so good.

PM

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SNOW SPEEDSTER

(Continued from page 88)

struct the template pieces and tack them in place with finishing nails. Rout one edge on each piece taking shallow cuts to avoid splintering the ash. To rout the opposite edges, remove the template pieces and supports, flip them over and reassemble. Clamp the slats together, secure a guide to the top front section and trim the ends with a sabre saw (photo 13). Cut the straight ends to length on the table or radial saw.

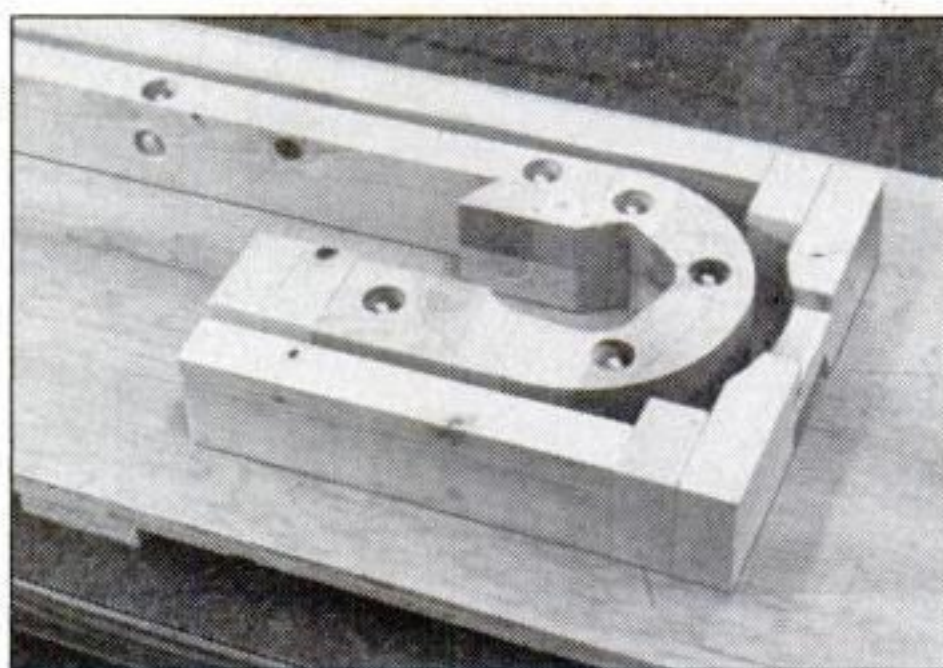
Putting it together

Before assembling the toboggan, sand each slat first with 120- then 220-grit sandpaper. Cut six 1 1/4 x 15-in. cleats from 1 3/16-in. solid ash stock. The 1 1/4-in.-thick nose cleat must be made from heavier stock or you can laminate two pieces of 1 3/16-in. material. Install a 1/4-in.-rad. rounding-over bit in your router and round the upper edges of the six

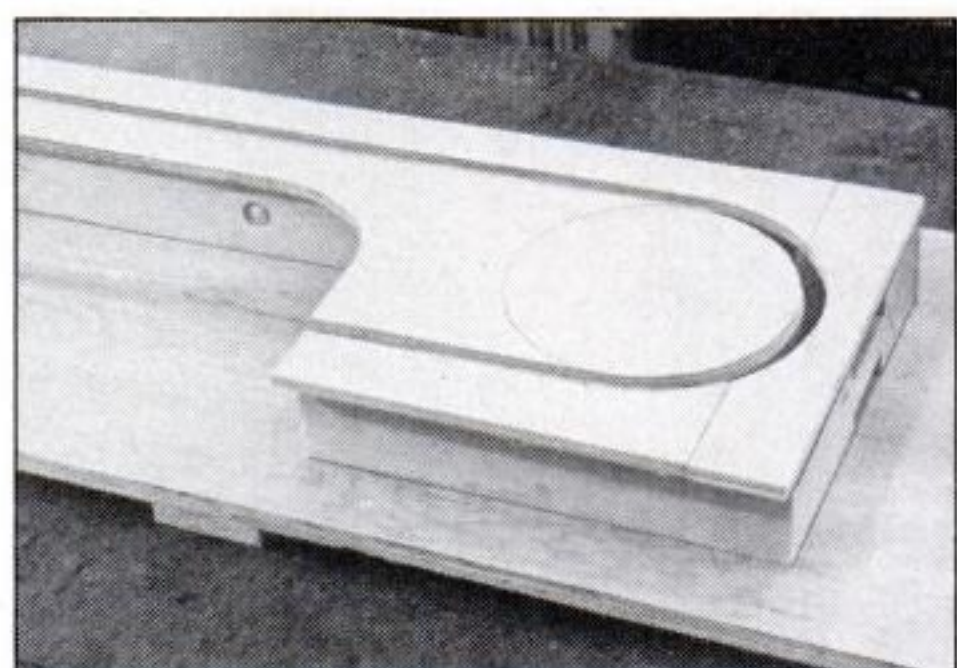
slat cleats and the two forward edges of the nose cleat as shown in the drawing. Then, use a 1/2-in.-rad. rounding-over bit for the remaining nose cleat edges. A dado blade mounted in the table saw cuts the groove in the nose cleat.

Mark the rope and screw-hole positions as shown in the drawing. With the slats clamped together, slip the nose cleat in place and bore pilot holes for the 1 1/4 No. 12 solid brass screws. Then, remove the cleat, bore and countersink the rope, screw shank holes and install. Remaining cleats are glued and screwed in from underneath. Countersink these screws 1/16 in. below the surface.

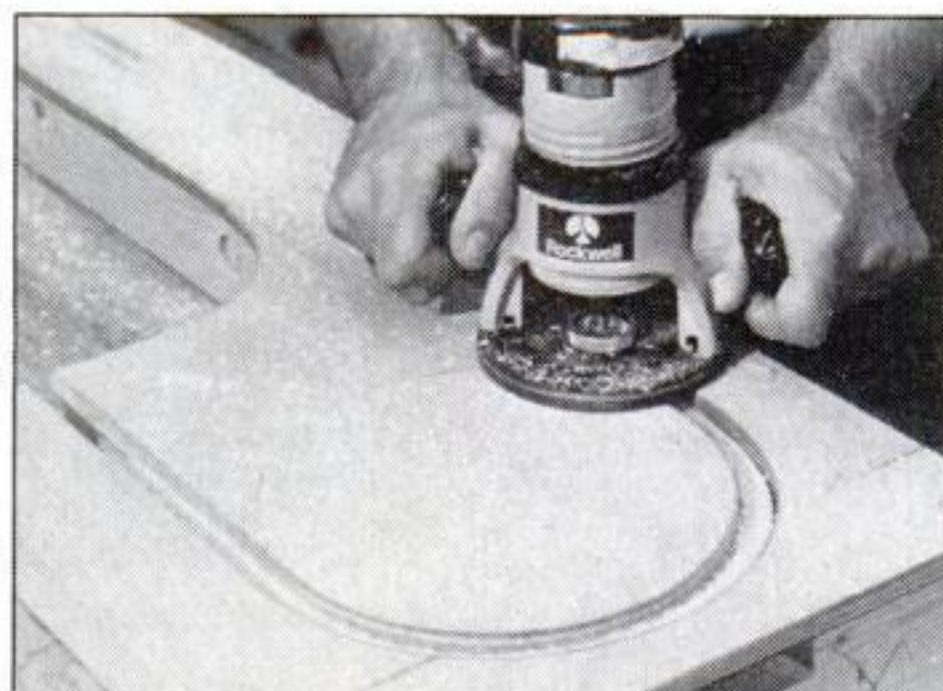
Choose a varnish with high water resistance and additives to filter out the sun's ultraviolet rays which tend to turn the wood gray. We applied five coats of Defthane Clear Gloss #1 Polyurethane Varnish and topped this off with two coats of paste wax. Finally, install the rope as shown in the drawing, pulling it tight and knotting it at the rear. **PM**



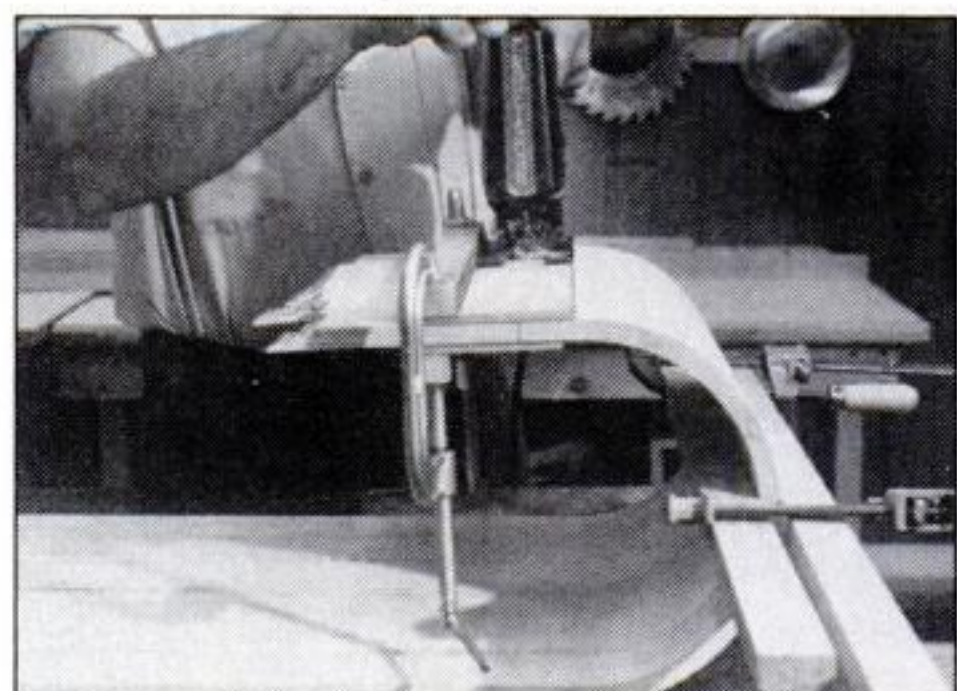
10 Attach the template support blocks to the base with 1 1/2 No. 10 fh screws. Notches in the end block ease the slat removal.



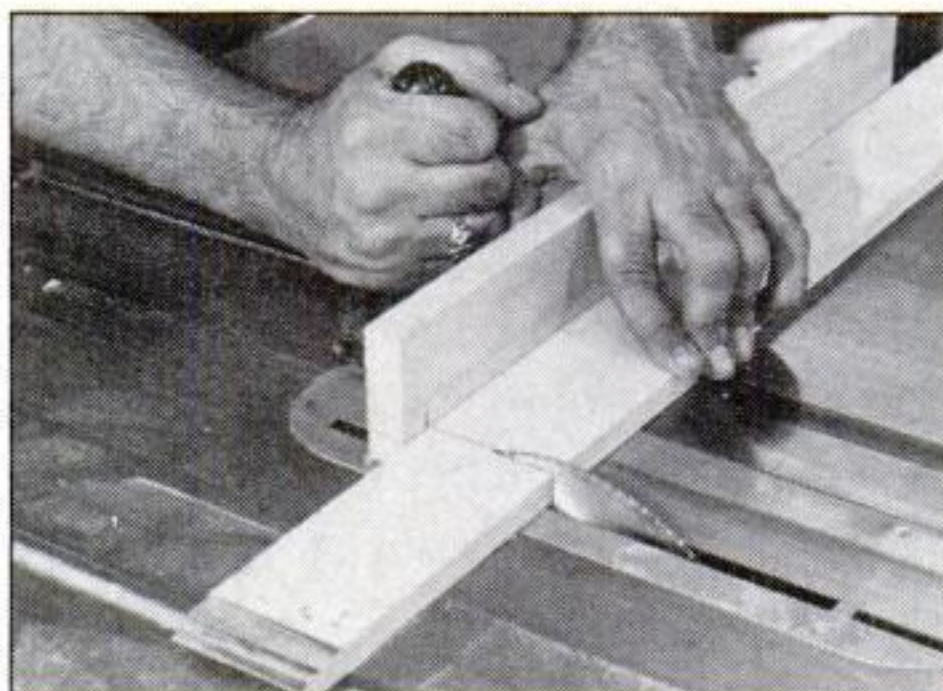
11 The four template pieces create a 7/8-in. slot to guide the router when trimming the slat edges. Secure with finishing nails.



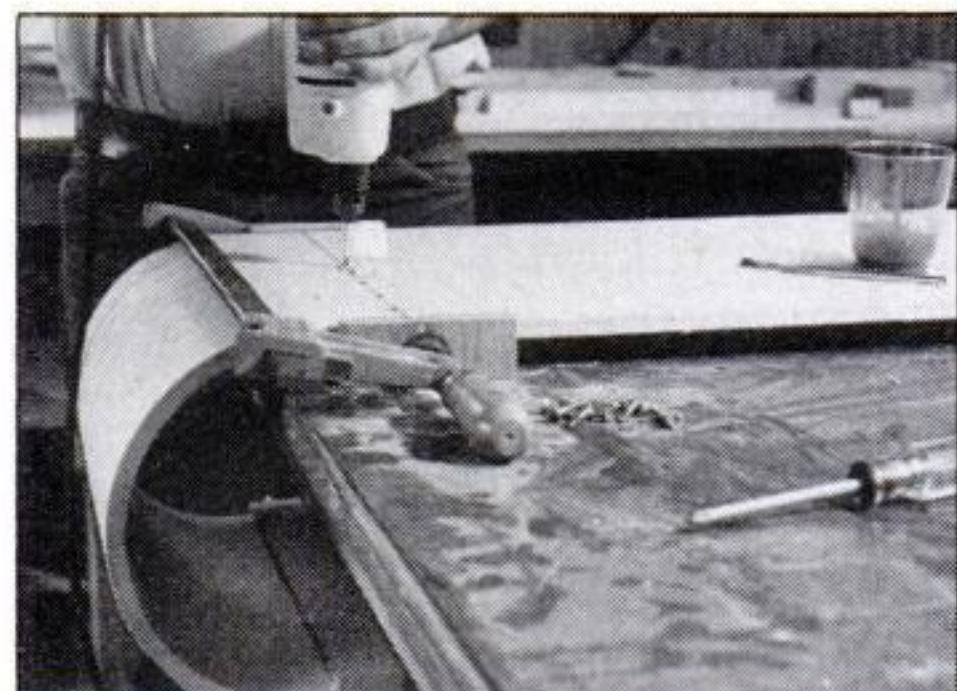
12 Use a straight bit and guide bushing to dress the edges. After one edge on each piece is done, disassemble and flip over.



13 Clamp the slats together with a straightedge to guide the sabre saw. Before unclamping, mark the rear cut-off line.



14 The straight ends of each lamination are cut individually on the table or radial-arm saw. Sand slats after trimming is done.



15 Clamp each cleat in place and bore pilot holes for the 1-in. No. 12 solid brass screws. Countersink 1/16 in. below surface.

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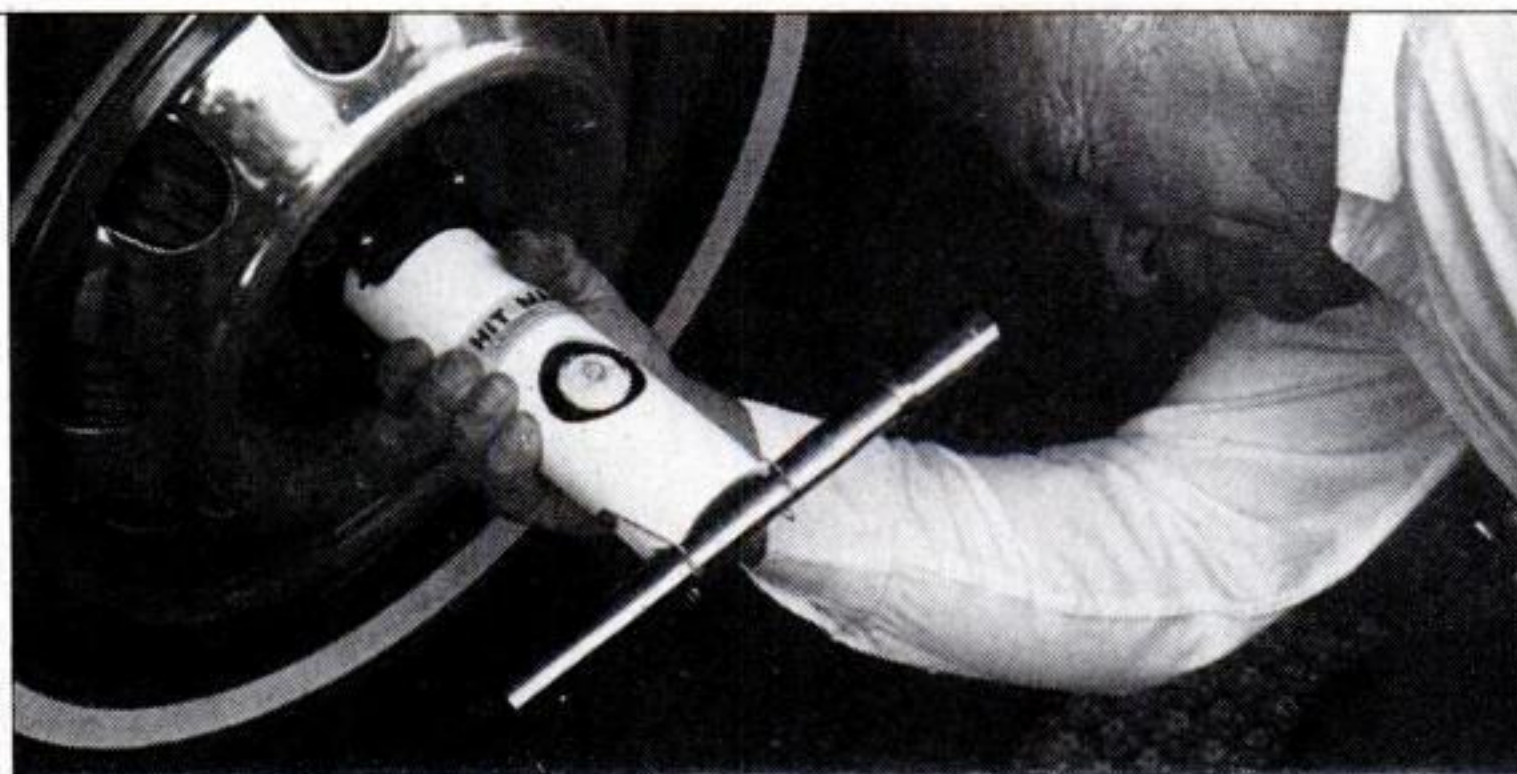
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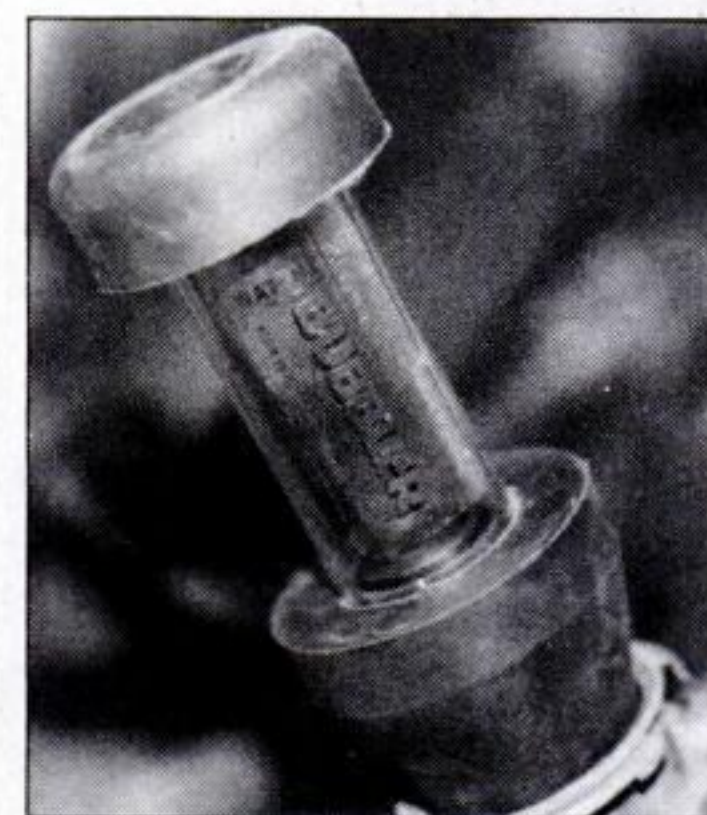
There's even a simple way to calibrate the scopes while they're attached to the car. It costs \$89.95, shipping included. You can order it from Hit-Man Alignment, 185 Pleasant Way, Penfield, NY 14526.

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Why it turns a funny color and smells bad?

Maybe you've got a leaky head gasket, or even a cracked block or head. If it's really bad, you can see bubbles forming in the radiator as the combustion gases find their way into the



water jacket. But smaller leaks are tough to find. The Bubbler will show leaks bubbling through the water in its clear-sided plastic body. Just let the engine idle while Bubbler plugs the radiator neck. It's \$24.95 in auto stores, or call (800) 445-9781 to find the store nearest you.

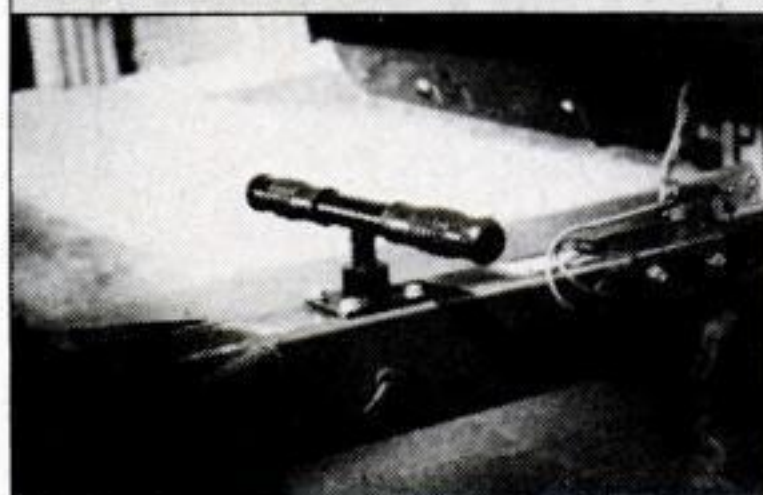
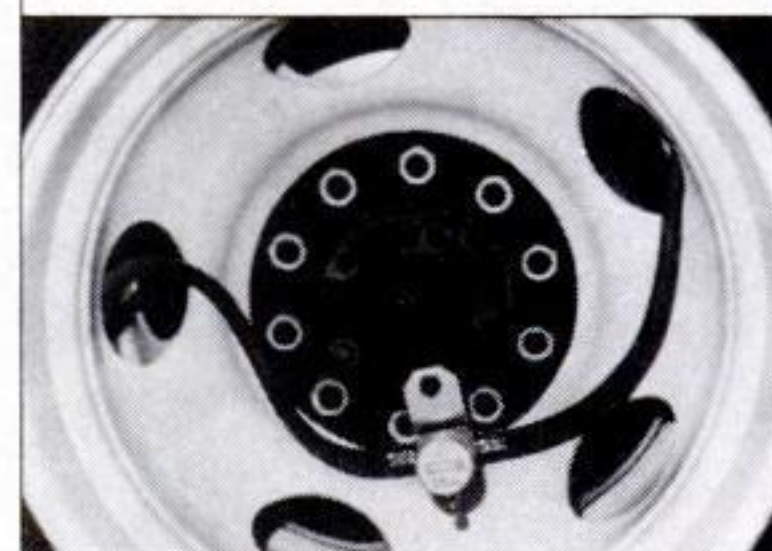
It's A Clean Machine

There's a time-honored tradition of cleaning greasy parts in a pie tin full of kerosene. This is not a good idea, because the kerosene is a serious fire hazard. You have to dispose of the mess, and *then* sneak the pie tin back into the kitchen. Bio-Solve systems has a parts washer that uses a water-based, heated, nontoxic solvent that can be washed into sewers after it's dirty. The circulating pump has ground-fault interruption (GFI) circuitry for safety. The solvent is nonflammable, so it's okay to use inside, with no danger of the pilot light on your water heater touching off an explosion. The 20 x 12 x 8-in. unit, No. B-800, is meant for countertop use, holds 4 gallons of solvent, and costs \$259 from Meyers Mfg., 2925-E East Chestnut, Springfield, MO 65802.



Separate Isn't Equal

Uneven pressures in the dual rear wheels can mean poor tire wear, bad handling, and reduced fuel mileage. Crossfire is a tire-pressure equalizer that provides a single fill point, even inflation and isolates one tire if a slow leak drops pressure by 10 psi. It's \$85.64 from Dual Dynamics, P.O. Box 80436, Lincoln, NE 68501, (402) 467-4341. **PM**



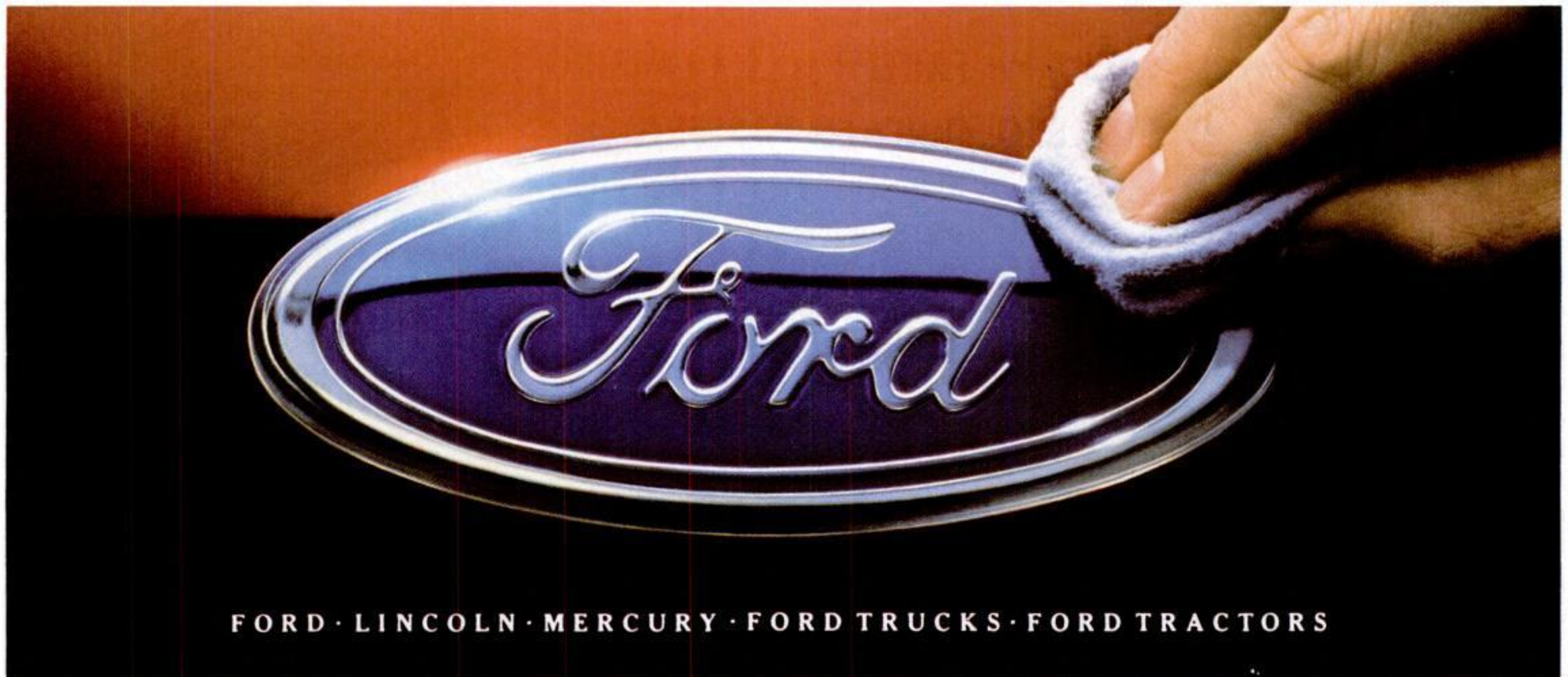
Get A Handle On It

Hitchin' up the boat or snowmobile trailer can be serious exercise, especially if you forgot to hitch up before you loaded all the gear into the forward compartment of the boat. Tongue weight of the trailer could wind up being a number about even with the national debt.

Compounding the problem is the fact that there's nothing to grab onto on the tongue of the trailer, and if two people try to bend over and lift together, they'll probably just whack their heads together.

Trailer Mate provides a fold-away handle so two *can* lift more easily than one. It costs \$17.95. You can order Trailer Mate from Anderson Automatics, 6401 Welcome Ave. N., Minneapolis, MN 55429, (612) 533-2206, but ask at your local trailer accessory supplier first.

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ASTRO/AEROSTAR

(Continued from page 92)

gear." Several owners mentioned the harsh shifting characteristics, but Chevrolet told us this has been rectified as a running mechanical change. Another change since we completed the survey has been the Astro's price. At press time, the Standard Cargo Vans carried a manufacturer's suggested retail of \$9262, Passenger Vans \$10,298. Although the Astro Van didn't score a perfect 10 (no vehicle ever does), the reservations about it were minor and overshadowed by considerable praise.

Ford Aerostar Van/Wagon

In keeping with the Ford family "aero look," the Aerostar is more stylish than its boxier rivals. It's generally wedgier than other minivans, which adds up to about five points less drag: a 0.37 C_d versus the normal 0.42.

It's no surprise, then, that nearly half the Aerostar owners we surveyed confessed to being swayed by the new minivan's contemporary appearance.

One respondent affectionately referred to this 2-tone van as the "aero anteater." Another called it an "SST on wheels." A Michigan engineer told us, "The Aerostar looks stylish enough so my wife and I feel comfortable driving it to semi-dress up social events." In all, 41.6 percent pegged styling as their main reason for buying the Aerostar.

The next-strongest reasons were roominess and overall size, at 41.3 and 14.5 percent, respectively. "The Dodge Caravan was too small, and the Chevy Astro seemed too much like a full-sized van," opined a Nebraska farmer.

"I'm a girl-scout leader," added a Florida nurse, "and I can get half my troop into this van, which means we need fewer drivers for our many trips."

Once the purchase was completed, comfort, handling and roominess emerged as the Aerostar's best-liked attributes. And one thing that contributes to the Aerostar's comfort and spaciousness is the longest wheelbase in its class: 118.9 in. A long wheelbase makes the ride smoother. Even so, ride quality got mixed reviews, with most owners agreeing that over-the-road smoothness increased as they added weight: the heavier the load, the better the ride.

Drivers praised seating comfort, and a Florida retailer commented, "I have a bad back, and the bucket seats in our XLT Aerostar, with their inflatable lumbar supports, are the most comfortable I've ever sat in. I could use them in my living room." But a few back-seat riders considered the rearmost bench seatback too upright, with too-small armrests.

(Please turn to page 114)

TransAmazon Rallye

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The Exploration Society of America

1912 St. Charles Avenue
New Orleans, Louisiana 70130

Homeowner Drills His Own Backyard Water Well

A tip from his wife turned into a money-saving hobby.

Interview with Capt. Charles Anders, Airline Pilot

I'm Rex Roach, Factory Sales Manager of DeepRock Mfg. Co. Today I'm talking with Capt. C.H. Anders of Atlanta, Ga. who who is an airline pilot. Capt. Anders, you purchased a Hydra-Drill about 3 months ago. Are you having pretty good luck?

A. Yes, I haven't drilled a well yet that I didn't hit water, so I consider that pretty good luck.

Q. Capt. Anders, what made you decide to drill your own well? Why not hire a commercial driller?

A. I had planned to do that. Then my wife saw this ad about the Hydra-Drill and how you can drill your own well. She was kidding me about it because I had told her how I helped dig a well when I was a boy. But I got the literature and it was so interesting I decided to order one.

Q. How many wells have you drilled?

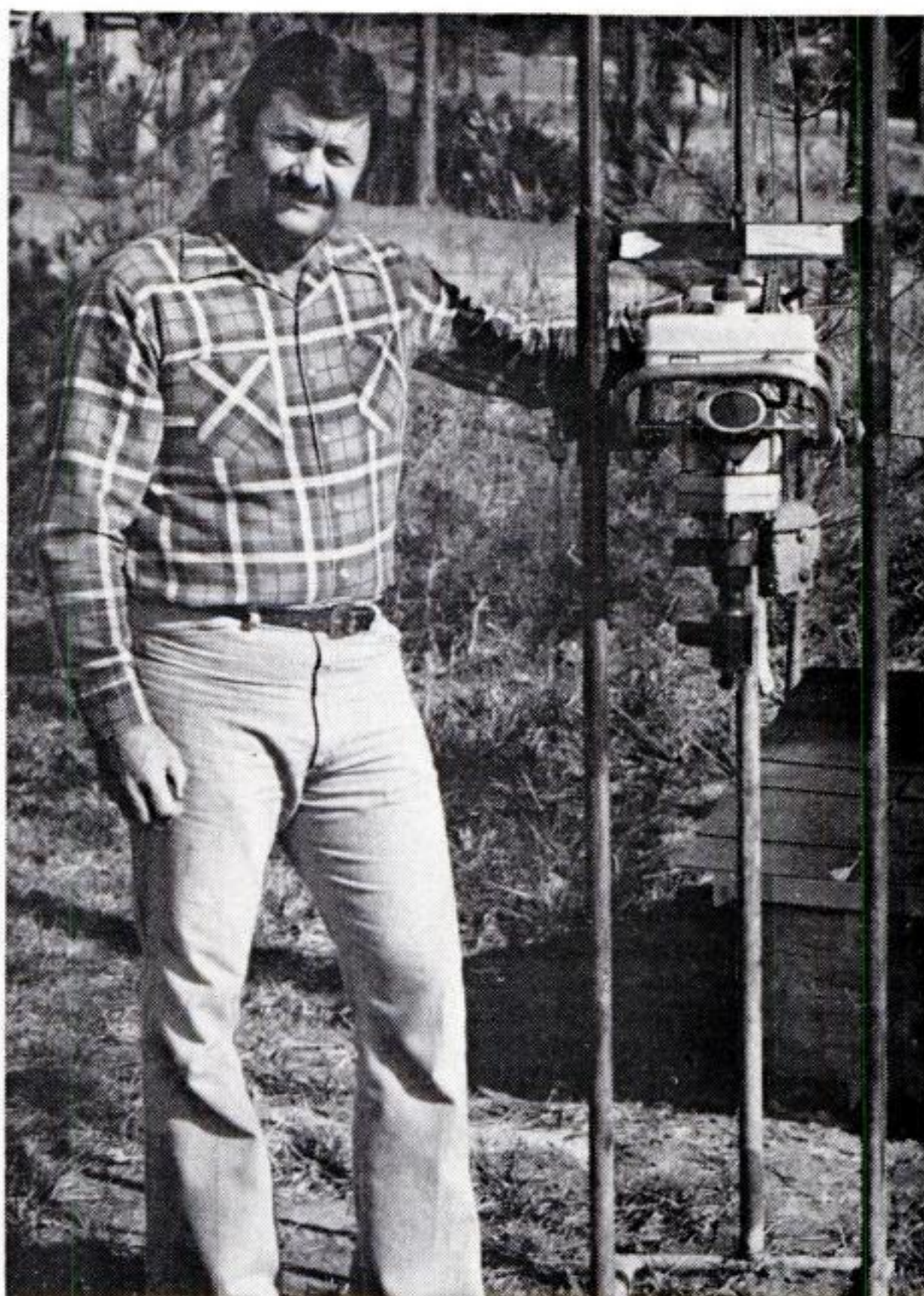
A. Four — actually, I'm drilling the fourth now, and it looks very promising. I'm already down about 75 feet, and I'll probably go another 30 or 40 feet. I expect to get about 600 gallons of water per hour at that depth.

Q. Is that good?

A. Around here, it sure is. Some of my neighbors hired commercial drillers and got about 300 gallons per hour.

Q. That's a lot of water. Why do you need more?

A. Well, for irrigation — you



know, flowers and sprinkling the lawn and things like that. This is a dry area. We just don't get a lot of rain like other parts of Georgia. In fact, we've really had a drought here for over a year, and a lot of people have had a well drilled recently.

Q. But you had never drilled a well before?

A. No, but I saw how simple it is. It's really fascinating how this Hydra-Drill works. It's not

complicated, and it's very easy to operate. Anyone could do it.

Q. Could you drill a well by yourself?

A. Yeah, if my neighbors would let me. Every time I start drilling, they come drifting over wanting to help. It's more like fun than work and everybody wants to try it.

Q. What do your fellow pilots think about your well drilling?

A. At first they thought it was a joke. Then they came out and saw the green lawn and all the sprinklers going full blast — they tried to buy the Hydra-Drill from me. I had to promise to drill wells for a couple of them.

Q. It sounds like you are getting into the well drilling business.

A. Not really. I plan to keep flying for a long time. This drilling wells for friends is just a hobby, and I'm enjoying it. The Hydra-Drill has already paid for itself so I'm doing it just for the fun of it. It's really something to see that drill go down, and when that water starts flowing, you feel like you've really accomplished something.

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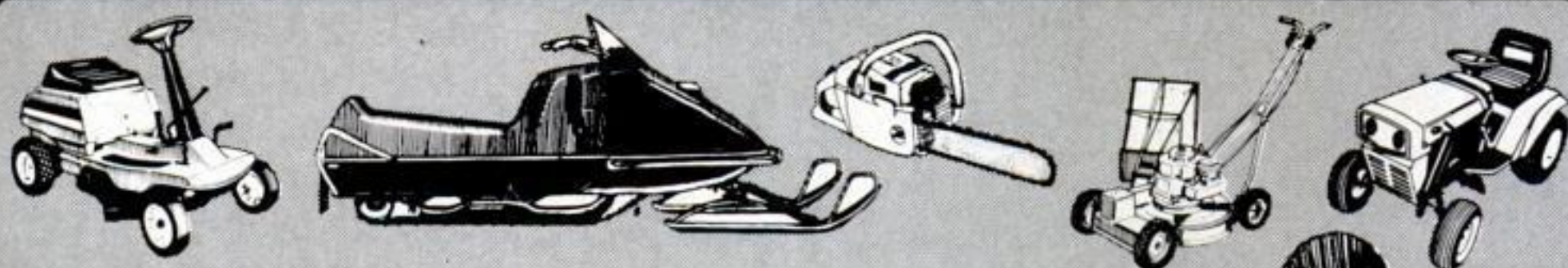
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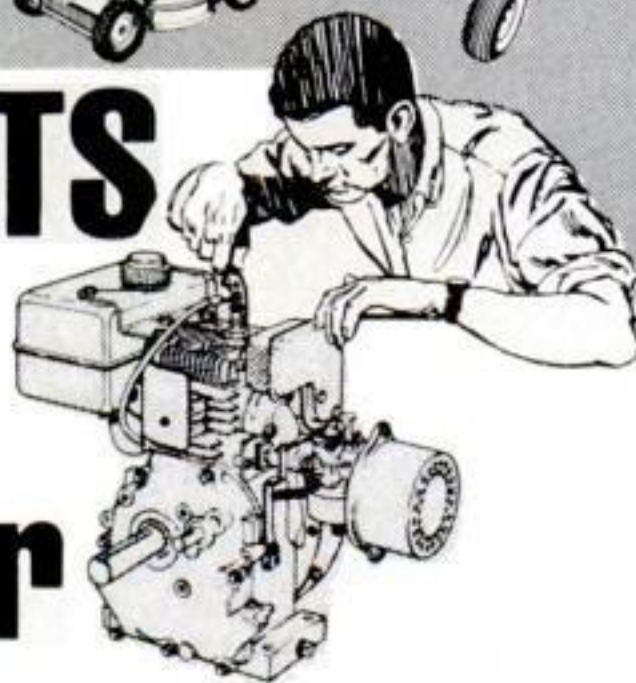
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ASTRO/AEROSTAR

(Continued from page 112)

A few owners remarked on the lack of storage compartments. "The glovebox is a joke," observed a California school administrator. "This vehicle needs more bins and pockets for holding maps, cassettes, hairpins, whatever. It could also use ledges on that large dashtop surface to keep things from sliding."

Our questionnaires included a large number of owners of very early-production vehicles—those sold between May 1985 and January 1986. Early Aerostars had some problems that later ones didn't, including a couple of factory recalls. The first recall was for noisy wipers, a minor ailment, easily corrected. The second, more serious recall involved 42,000 early Aerostars that might have had weak rear underbody welds. These welds, if they cracked, could have affected rear suspension mounts and, indirectly, steering control.

Ford dealers were sent steel brackets to be riveted over or alongside the welds. Ford reports that no welds actually ever cracked in service, but the factory wanted to be safe. As a result of the recall, though, we heard grumbles from a few owners who'd put off vacations or had been inconvenienced by waits. "When we took our Aerostar in for the weld recall," said an Iowa meatcutter, "the parts and tools Ford sent to the dealer weren't right, so the shop kept our van for over a week. However, they did give us a new car to drive."

Another source of apprehension had to do with the mechanical valve lifters in the early optional 2.8-liter V6. The factory called for a free lifter adjustment at 7500 miles, paid for under warranty, and recommended readjustment every 30,000 miles thereafter.

However, Ford has since eliminated this potential irritation by making the Taurus/Sable 3.0-liter V6, with self-adjusting hydraulic lifters, standard equipment in all Aerostars.

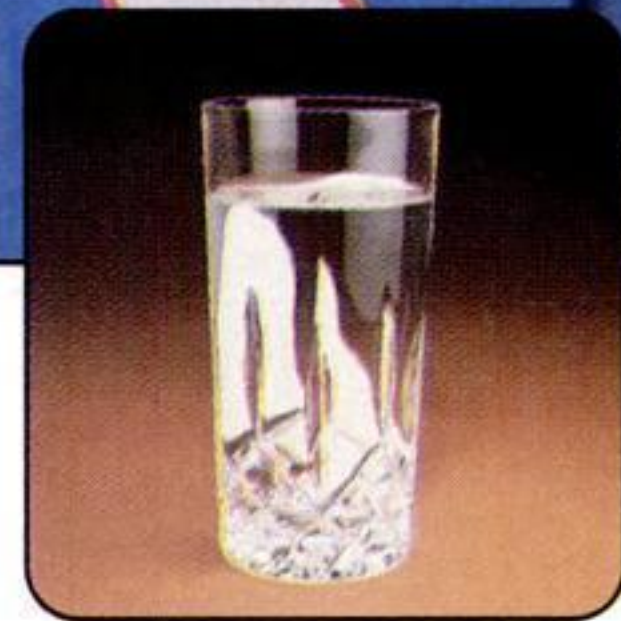
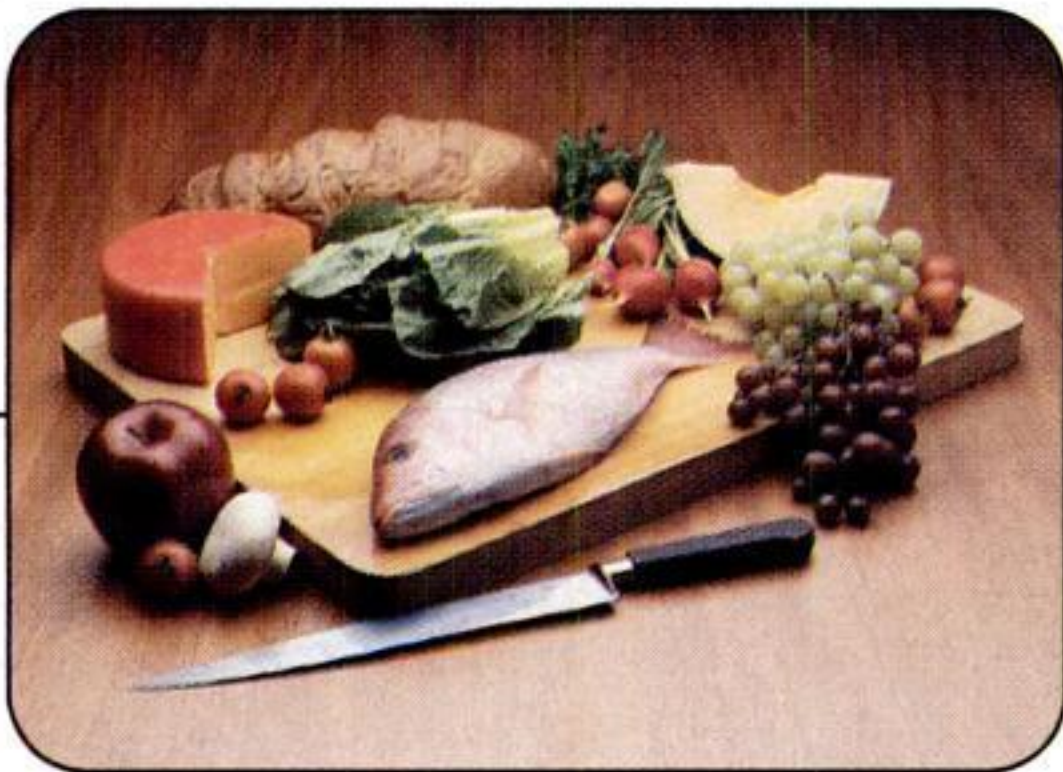
As for performance, "The V6 engine has a lot of pep," observed a Missouri truck driver. A Minnesota teacher confided, "We wanted the V6 and rear-wheel drive for towing our boat." Actually, the rwd doesn't make that much difference, but the Aerostar's more powerful V6 and its beefier structure might make this a better towing choice than smaller fwd minivans.

Owners of the 2.3-liter Four averaged about 6 mpg more than the 2.8 V6. The 4-cylinder Aerostar posted a remarkable 22.6/27.0 mpg city/highway. Even at that, relatively few buyers opted for the Four (only 7.9 percent)—which is certainly a reason the Four was dropped for '88.

A Minnesota retiree pointed out to us
(Please turn to page 119)

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that, "Before I left for Florida, our Aerostar was getting only 10 to 14 mpg. Mileage improved all the way down to Miami, where we eventually averaged 24 mpg."

Ford makes a big point of stressing that "Quality Is Job 1," and most of our respondents gave Aerostar workmanship high scores. Fully 95.5 percent rated overall workmanship good to excellent. Paint quality, body finish and interior fits got slightly higher marks than mechanical finesse. "The manual transmission and I aren't quite friends yet," mused a Michigan medical technician, and a Louisiana draftsman mentioned, "Driver's window leaked water badly, but the dealer fixed it by replacing a rubber molding."

A self-employed Michigander pointed out an objection to the Aerostar's engineering: "You can take out the ignition key while leaving the automatic transmission in gear, not in Park. If you park on a steep hill or driveway, the van can roll."

The Aerostar's optional sound system elicited considerable praise. "At \$151 more than the base AM radio," noted an Alabama salesman, "the 6-speaker AM/FM stereo radio/cassette is a real bargain. It comes with rear-seat tuning and volume controls plus two stereo headphone jacks, each with individual volume settings. All normal speakers can be faded out so only the headphones receive a signal. It's ideal for commuting." And a California speech therapist echoed, "Our 5-year-old listens to those rear headphones, and this saves me at least two pain killers on each long trip."

Popularity never comes cheap. The average price paid for the Aerostars in our survey was \$13,228, and the manufacturer's suggested retail for a standard wagon model through the 1987 model year was \$11,132.

Still, the overall impression of the Aerostar is one of admiration and satisfaction. Riffing through our questionnaires, it's not hard to find praises. An Illinois meatcutter calls his Aerostar, "a very fun minivan to drive. Ford gets an A+ in my book!" An Ohio stockbroker: "This van is very complete, with many options, but everything works! Pre-delivery prep was outstanding, paint looks great, body fits are all perfect, and the Aerostar meets or exceeds my needs."

An Iowa supervisor: "Best utilization of interior space, least wind resistance, superb quality control, unbeatable sound system. It's the finest vehicle I've ever owned. Fantastic!" And a California engineer: "We could have spent thousands more for another minivan, but none we tried was nearly as comfortable to drive or ride."

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Shadow Turbo (top) logged 11,000 miles. Tempo 4wd (above) ran up 9000 miles for our test, mostly in 2wd weather conditions.

THE new model year is here and manufacturers are clamoring to get '88 cars into our garage, so we're bidding farewell to the '87s in our long-term fleet.

Dodge Shadow Turbo

The Shadow wound up being our weapon of choice for carving up Manhattan crosstown traffic. When we had to be there in a hurry, its strong midrange acceleration was perfect for outrunning taxicabs on the West Side Highway. It was a tough little street fighter, but these are tough little streets and in the end the Shadow's suspension was overmatched.

When new, the shock damping was capable of keeping the tires in contact with the pavement most of the time. But after 12,000 miles, the Dodge Shadow was delivering full traction mostly between potholes.

By the end of the test, even backing out of the driveway, over the 2-in. lip at the street, meant three oscillations before the worn-out shocks finally damped the pitching of the front end.

Spirited driving, which the engine and gearbox were certainly ready for, demanded care. Jerky entry into corners was *verboten*, because everything had to be stabilized before the turbo

kicked in. If not, the extra power could put you into the weeds faster than you could say "torque steer."

The Shadow's suspension deficiencies are really a shame, because the engine pulls beautifully from 2000 rpm all the way to the 6500-rpm redline. To aug-



Corvette Roadster: Name another car that can turn 13.96 quarter-miles, rocket to 150 mph and deliver over 20 mpg.

ment the generous powerband, gearbox ratios are spaced very closely, in the best road-racer style, making for satisfying mountain-road tomfoolery. However, the shift linkage occasionally hung up, yielding either Neutral or Fourth in a 3-2 downshift. This kind of difficulty is typical of the Bowden-cable shifters on transverse-engine fwd cars.

We reported in the August installment of the Shadow's long-term saga (page 53) about a major coolant leak somewhere in the vicinity of the water-cooled turbo.

On two occasions since it was fixed, the engine overheated, once in line at a tollbooth (a *very* inconvenient place to

overheat). Adding 3 to 4 quarts of coolant to the radiator cured the problem, at least until the next time. Curiously, there never was any evidence of coolant loss at the overflow tank. We took to carrying a gallon of coolant in the trunk.

The cruise control developed a case of the hiccups, traced to stiff springs that bounced the brake pedal hard enough over rough pavement to switch the cruise off. That's not really a mechanical problem, but it did precipitate panicky visions of an empty fuel tank, electrical glitches or some other walk-home-type malady—until we thought to step on the gas or turn the cruise back on. And the catch for the spacious center console's lid started to stick, necessitating slamming the lid repeatedly to latch it.

Over the last 5000 miles of the 11,000 miles we racked up, the Shadow delivered 21.9 mpg, commuting into Manhattan and blasting down the New Jersey Turnpike on the way to the seaside resorts on the weekends. That's a 2- to 3-mpg improvement over the first few thousand miles. Oil consumption was a single quart since new.

The relatively straightforward Shadow stickered for \$7499 in '87, plus \$1791 for the Turbo option and \$244 for the premium sound system. With air conditioning, tint and sunroof, it totaled \$11,181.—Mike Allen

Tempo 4wd

It's hard to believe that two cars so similar in size and cost could feel so different. In contrast to the Shadow, the Tempo was firm, competent over rough roads with good steering feel, and maddeningly slow away from a traffic light.

The Tempo we ordered early in the model year didn't show up until the snow had all but stopped flying. So we had little opportunity to test the effectiveness of the part-time 4wd.

Part-time means not suitable for use on dry pavement at any time, at the risk of frying expensive parts. But for backing out of a slick parking space, or crawling down a slushy freeway, it's pretty handy.

Ford's version is certainly easy to operate. There's a switch, with indicator light, on the dashboard. Just remember to turn it off when conditions improve. The Tempo's 93 hp, coupled with an automatic transmission (the only transmission available) and limited ground clearance add up to a range of operations that shouldn't extend to off-roading. It's also a bit too mild-mannered in town, and with four adults on board, the car had to work hard to keep pace with traffic. However, it cruised a long nicely once it built up a head of steam.

In contrast, the suspension seems to soak up potholes without really noticing them. If you need to take your mother

(Please turn to page 123)



SIT TO CHRISTMAS DINNER at Mrs. Bobo's Boarding House in Lynchburg, Tennessee, and you're likely to be there a while.

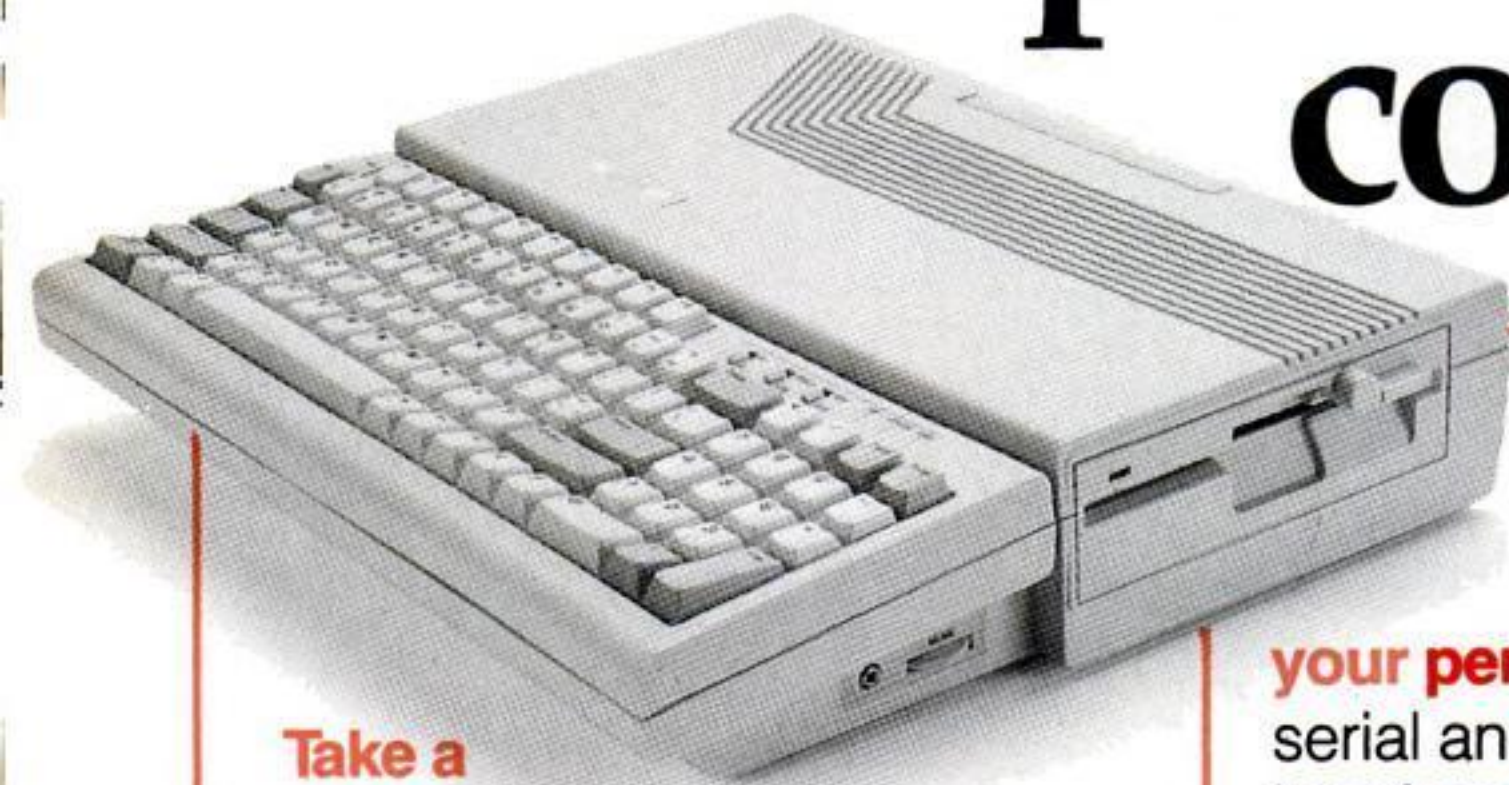
The occasion calls for unhurried enjoyment of dishes from every lady present. Lynne Tolley's baked turkey; Mary Ruth Hall's scalloped oysters; Diane Dickey's tipsy sweet potatoes; Mary Kathryn Holt's boiled custard and coconut cake. And compliments from one and all. All of us in Lynchburg hope your Christmas dinner will be equally unhurried. And equally well attended by family and close friends.

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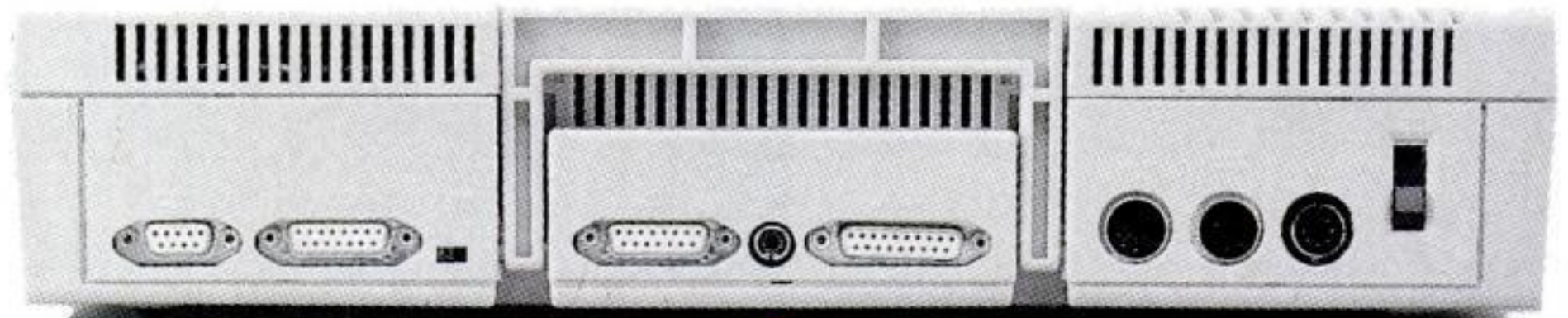


Choose from the largest software library in the world. The Laser 128 runs Apple IIe and IIc software, which makes it nice for you and your family, because children can use the same programs at home that they learn on in school. The Laser 128 is a computer for the whole family.

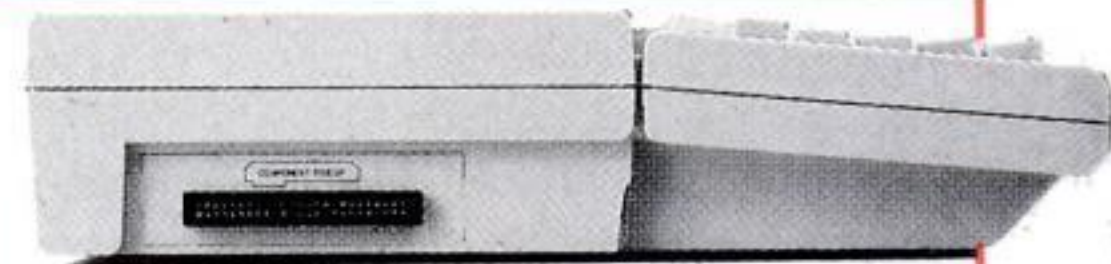


The Laser 128 has built-in interfaces for all

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color or monochrome monitor, or even a TV to it. Only the Laser has this much built-in as standard equipment.



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The Laser 128 includes an expansion slot to let the computer grow with your increasing demands.

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LONG-TERM TESTS

(Continued from page 121)

and her goldfish to the other side of town, the Tempo will get you there with Mom dry and the fish still in the bowl.

Underwhelming straightline performance notwithstanding, the Tempo's smooth ride was a real comfort on several longer trips, at least when we weren't in any particular hurry. Fuel mileage hovered around 20 mpg, town or highway. That was disappointing, but understandable considering the constant use of full-throttle acceleration to keep from holding up traffic. And the trips we made were not done with fuel economy as a priority.

The driver's seat upholstery that started to look a little puckered within a few weeks of delivery didn't get any worse. And on hot days the cruise control either went on strike altogether, or surged annoyingly. That idiosyncrasy became academic when the speedometer cable broke (for the third time), disabling the cruise for the duration of our test. We returned the car to Ford a few weeks later.

Our loaded version stickered at \$12,570, including the 4wd. We weren't too excited about the Tempo the last time we wrote about it. We're still not. But aside from the indifferent performance of the 2.3 4-cylinder motor, we haven't got any major complaints either. Mom liked it, though.

—Mike Allen

Corvette Roadster

Yes, we know that long-term test reports are supposed to be really brutal hatchet jobs where we run the wheels off a car, then report to you readers how the No. 3 air cleaner screw backed out a quarter-turn.

Unfortunately for all you blood-thirsty car-haters, this long-term report, on our '87 Corvette Roadster, has to, of necessity, be different. This darn car has just kept on going, didn't break, kept on getting stronger, kept on getting better fuel mileage as it got older, and was as reliable as the phases of the moon. What can we tell you?

Chevrolet has really gotten its act together in the Bowling Green, Kentucky, assembly plant, where all Corvettes are made. For instance, Corvettes in the past have been notorious for lousy paint. Our test car was black, which shows every imperfection. The paint on our test car was smooth and glossy and we can't even complain about that. In fact, we can't really complain about much. Its fit, finish and overall quality is very, very high.

Take the engine. As we told you in the last installment, this is a standard 350-cu.-in. (5.7-liter) small-block V8 backed up with the 700R4 automatic transmis-

sion and 2.73 rear-axle gearing. The thing has never failed to start on the first crank. And if anything, as we piled up mileage, it felt stronger and stronger. In our last installment, we reported that the car ran a best of 13.96 seconds for a standing start 1/4-mile acceleration run at Raceway Park in Englishtown, New Jersey. That is very fast—one of the quickest times we've ever recorded for any car.

What's even more incredible to us than the car's quickness and speed is its operating efficiency. We've used the car mostly for daily commuting into New York City. The daily run is a combination of New Jersey Turnpike cruising at 60-75 mph and stop-and-go nightmare traffic through the Lincoln Tunnel into Manhattan. We've now rolled up just over 13,000 miles on the car in this type of use, plus a couple of days of hard track testing. Now get this. Fuel mileage had improved from the 18.2 mpg we reported in the last installment to 21.1 mpg. And believe us, we drive the car hard. We floor it away from toll booths. We do burnouts when the spirit moves us. And we punch it a lot to pass slower traffic.

We don't care what you say. No car has a right to run 13.96 ETs, have a top speed of 153 mph and average more than 20 mpg. It's just not right. No car should be that efficient.

No doubt the 2.73 gear helps a lot here, as it allows the black Vette to loaf along at highway speeds with the engine turning just 1800-2000 rpm.

By the way, we'd like to correct a mistake we made in the last installment on this car. We said that we had ordered the car with the 3.07 performance axle ratio and, among other things, the Delco-Bose premium sound system. We also said that someone in the Bowling Green plant had made a mistake and installed the standard 2.73 gearing instead of the 3.07. Wrong. There is an ordering restriction on Corvette order blanks that says if you order the Bose sound system, you can't order the 3.07 gear. Why? We don't know. But we did miss the restriction. And since our order blank had both boxes checked off, they could only install one or the other of the options. They gave us the radio instead of the gears. So it was our mistake, not theirs. Sorry, guys.

This is going to sound silly, but the only thing we can criticize on this car is the windshield wiper control switch. It's located on the driver's door, for some reason, and is made of cheap plastic—not in keeping with the quality built into the rest of the car. It doesn't slide smoothly and simply is not satisfactory. Chevrolet Engineering should get on this one and install a high-performance windshield wiper switch in an otherwise high-performance car.

—Joe Oldham

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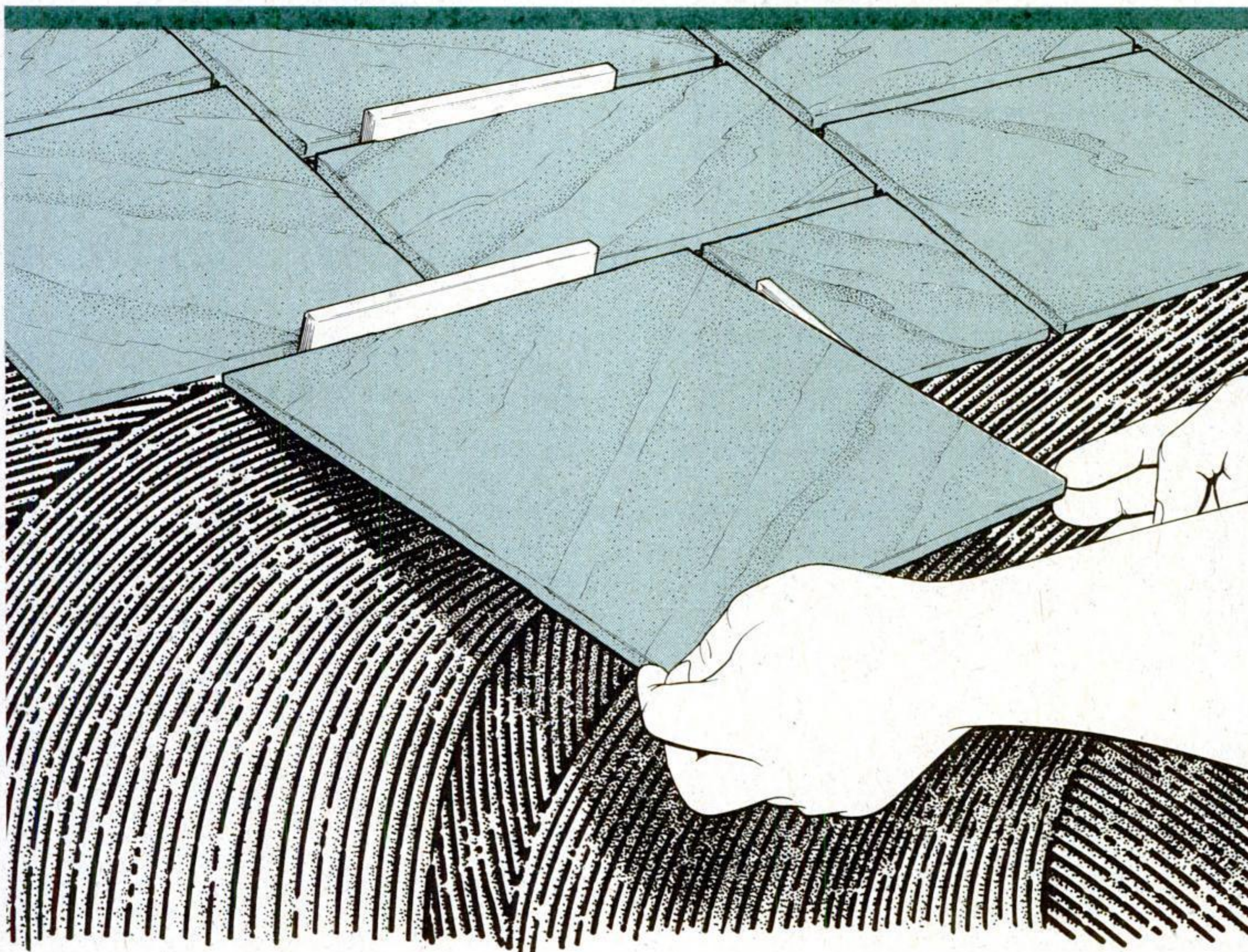


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THE BETTER HOME



How To Install SLATE FLOORING

IN many ways, slate is the perfect material for a foyer floor. It's durable, easy to maintain and has an elegance that tastefully accents just about any adjacent floor material. While slate may not be suitable for some rooms in your house, because of its cold feel and unyielding surface, it is entirely appropriate for a foyer which is used primarily for entering and leaving the house and is often exposed to a great deal of moisture.

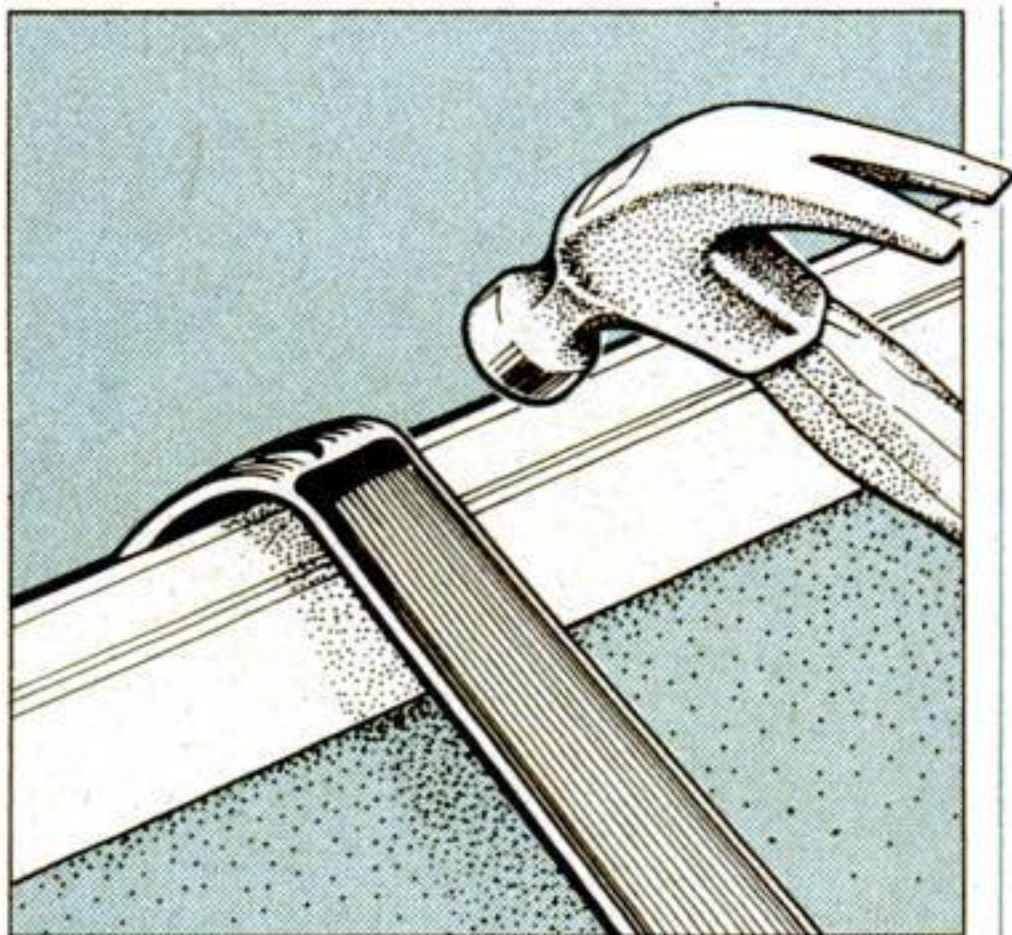
Traditional slate floors are set in concrete and the subfloors that support them must be lower than the surround-

BY PAUL BARRETT
Illustrations by George Retseck

ing floors to accommodate this extra thickness. The floor framing must also be strong enough to carry the extra weight. Because of this, a traditional installation is a difficult and expensive remodeling proposition. Fortunately, today's slate floor tiles are available in a fairly uniform 1/4-in. thickness and can be successfully installed over a standard wood or plywood floor using mastic instead of concrete. As such, slate becomes a relatively low-cost, high-quality

floor option for home remodelers.

For this story, we installed slate in a foyer that was formerly covered with carpeting. We purchased the slate from a local stone and masonry dealer and it came in boxes that contained 10 sq. ft. each. In addition to the slate, you'll also need the following, available from your slate dealer: proper mastic, some latex grout, a 1/4-in. notched trowel—to spread the mastic—and a flat-bottomed pointing trowel, called a Dresden trowel, to apply the grout. For a small area, like our 25-sq.-ft. foyer, these tools and materials cost less than \$100.



1 Remove shoe molding and baseboard by driving pry bar behind one end of board, then moving along length of wall.

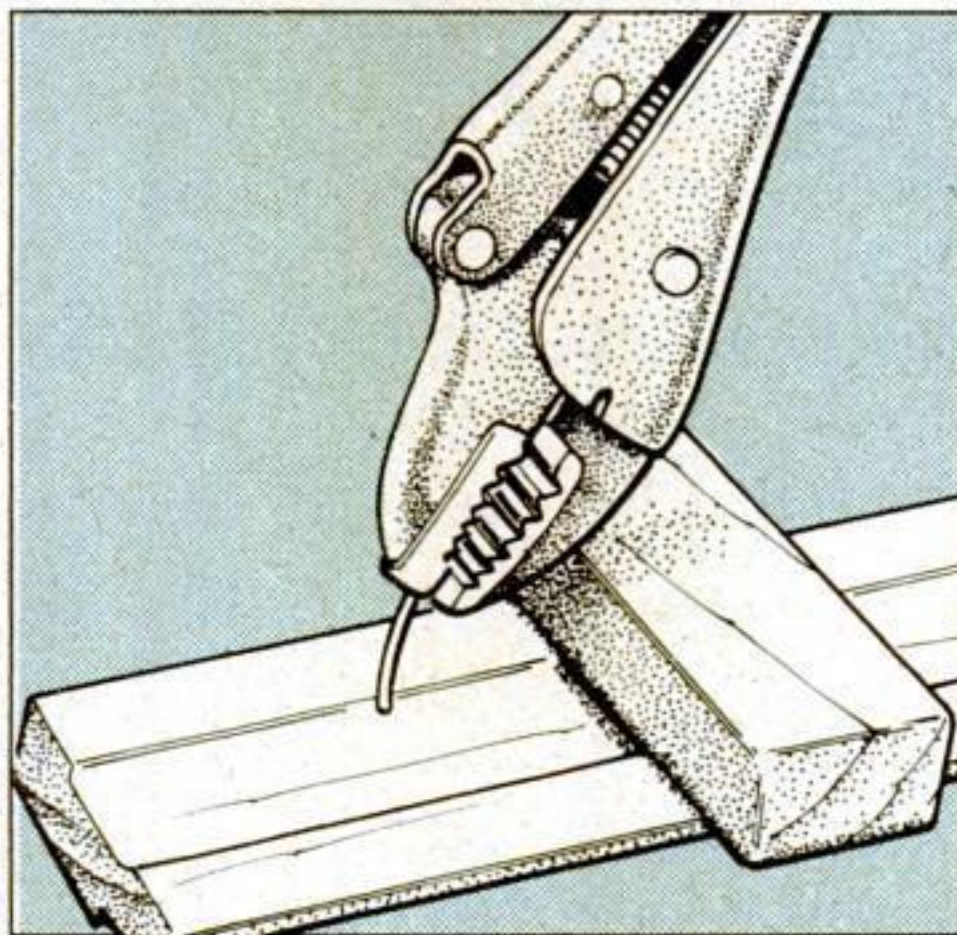
Preparation

Proper floor preparation is the key to a successful slate installation. What's required depends on the type and condition of the flooring surface. In our case, we had to remove the shoe molding and baseboard first, then cut the carpeting and pull it from the tack strip as shown in Fig. 3.

To remove the shoe, insert a flat pry bar behind the piece at one end and carefully pry it away from the wall. Continue moving the bar along the wall until the whole piece is free. Then pull out the finishing nails from the back side of the board using locking pliers and a small support block.

Once the shoe molding is removed, do the same for the baseboard. If you proceed carefully, you should be able to use the same trim after the slate is installed. Next, cut the carpet where you want the slate to begin with a sharp utility knife and straightedge guide. Then, pull the carpet off the tack strips and pry the tack strips off the floor.

At this point, inspect your existing subflooring for any potential problems.



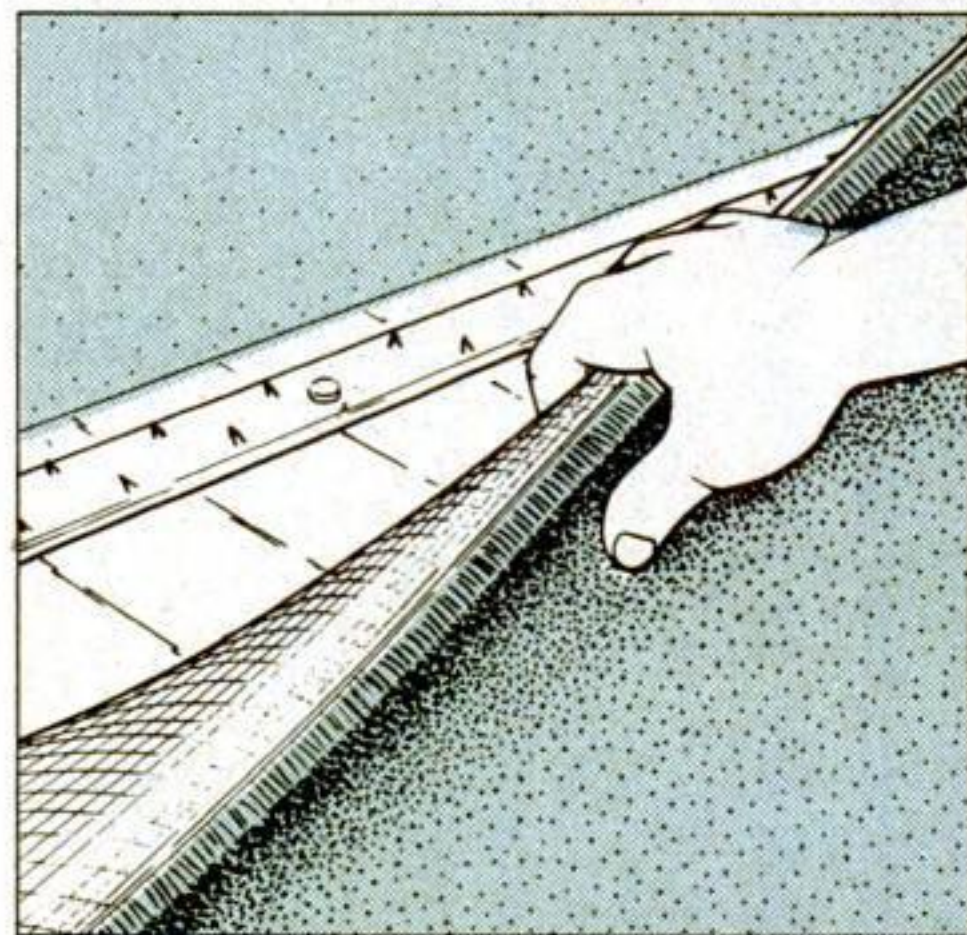
2 To avoid damaging trim boards, pull out nails from back side using locking pliers and small wood block for leverage.

Keep in mind that the tiles are rigid and, therefore, any resilience in the floor below can cause trouble later on. The slate may crack if the floor gives a great deal and if the floor moves just a little, the grout can break.

Problem solving

Your most common problem will be loose plywood or floor boards. These must be renailed with 8d common or box nails driven into the floor joists underneath. Another potential problem is material on the surface of the subfloor. For instance, if you don't have carpet but do have resilient floor tiles or linoleum, these will have to be removed and the adhesive underneath scraped away. This is a very time-consuming and annoying job. Also, if you have floor boards covered with paint or varnish, the finish must be removed by sanding with coarse-grit paper or scraping with a hand scraper.

For these reasons we recommend covering the existing floor with 1/4-in.-thick underlayment plywood. The cost is minimal considering the square foot-



3 To remove carpeting, cut it to line where slate will end using a sharp utility knife. Then pull it away from tack strip border.

age that's usually involved and it's the best way to achieve a sound surface.

To install the underlayment, cut the plywood panel to size and attach with flooring nails driven in a 4- to 6-in.-sq. pattern.

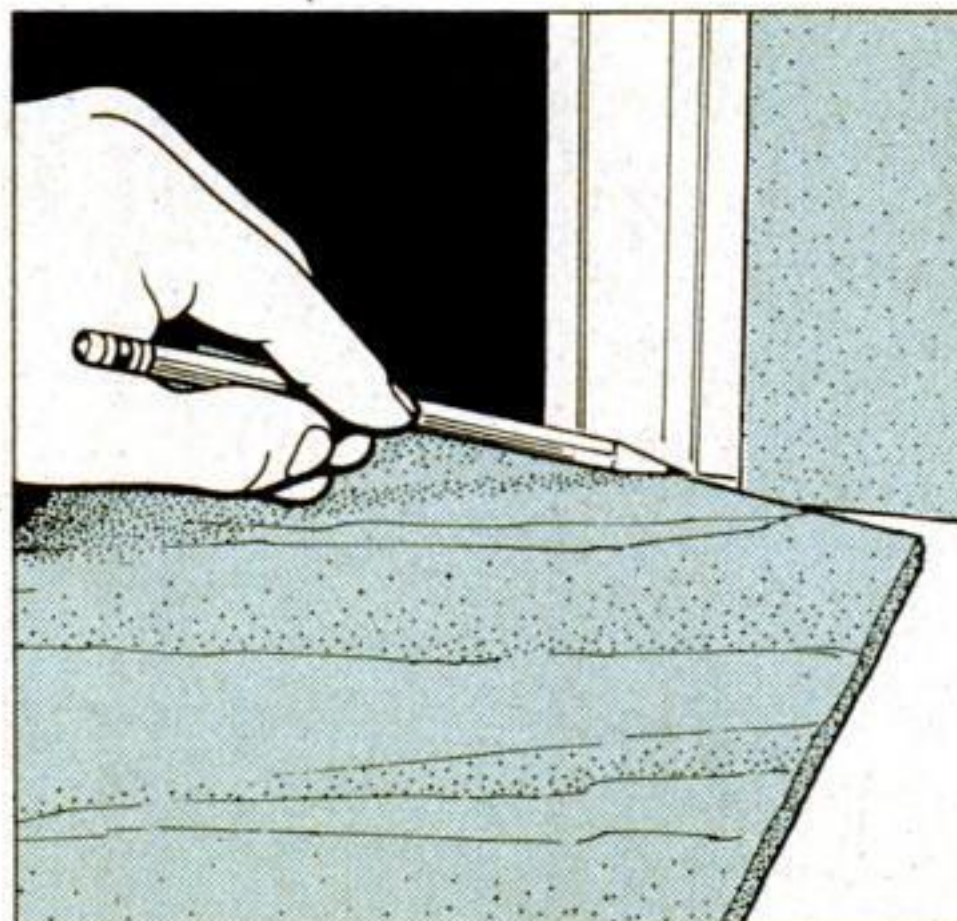
Sink the nailheads slightly below the surface of the plywood and then fill these depressions with floor patching material, such as Dashpatch. When the patching material is dry, sand it smooth using 100-grit paper, then vacuum all the dust from the floor.

Keep in mind that most foyers are small and, therefore, a single sheet of plywood would cover the area without a seam. But if your area is larger, simply butt the adjoining panels together and nail along the seam in a slightly tighter pattern. Fill with patching material and sand smooth. Make sure that you stagger the seam so it doesn't fall directly over any seam in the subflooring material underneath.

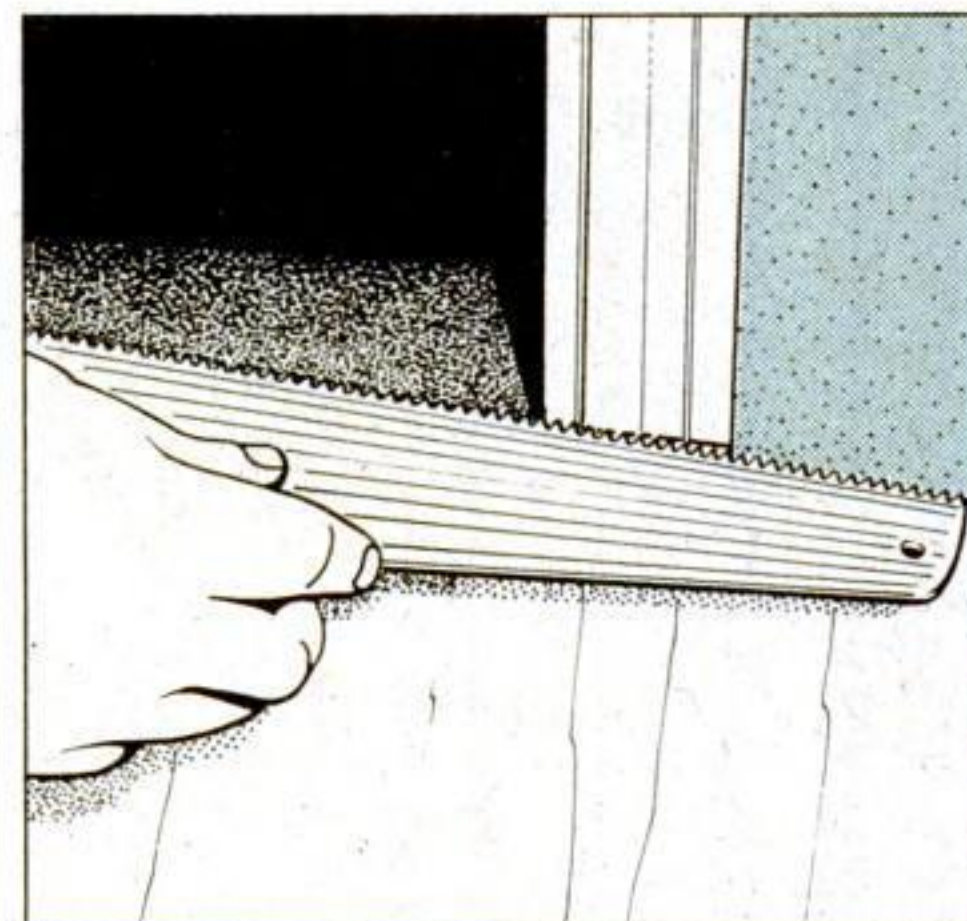
In addition to a firm surface, you'll need to make sure that the structure of the floor will not flex. Have a friend walk across the underlayment and



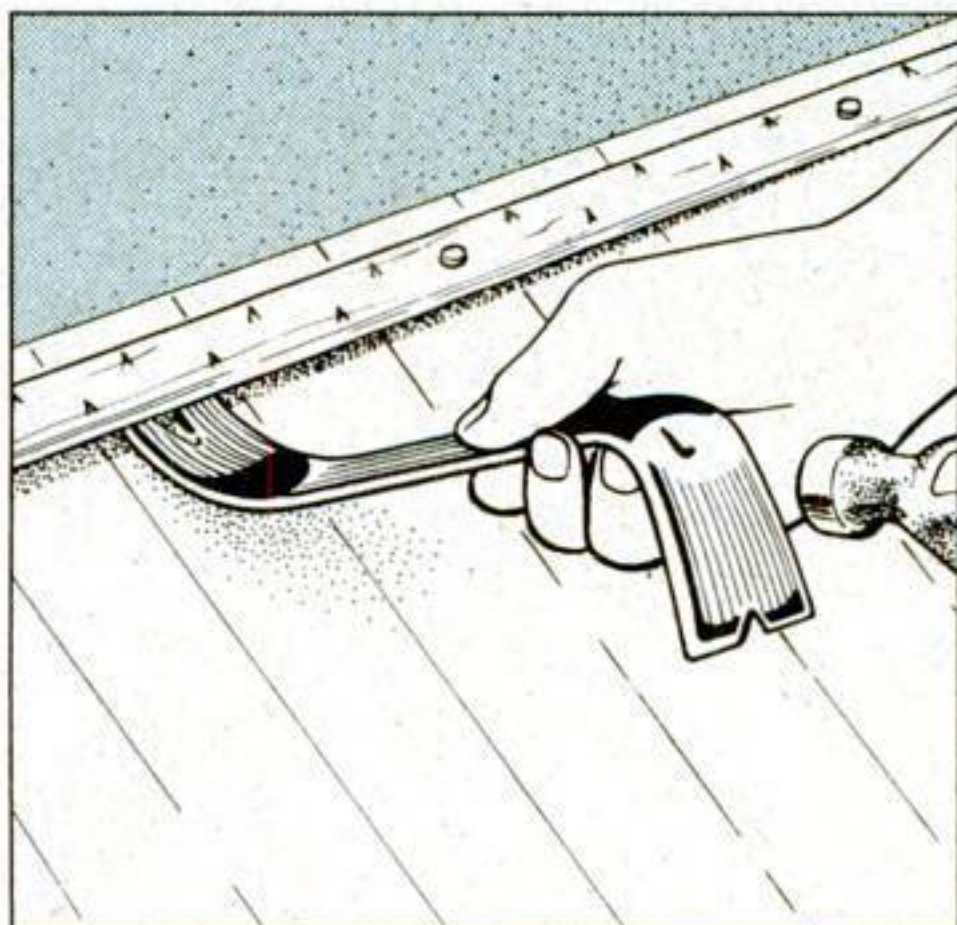
7 Set nailheads below surface. Fill holes and seams with patching compound. Let dry and sand smooth with 100-grit paper.



8 Bottom edge of casing must be cut off to accommodate slate. Place tile against casing and scribe proper cut line on surface.



9 Cut casing board using a sharp handsaw. Make sure to keep blade parallel to floor and cut on waste side of scribed line.



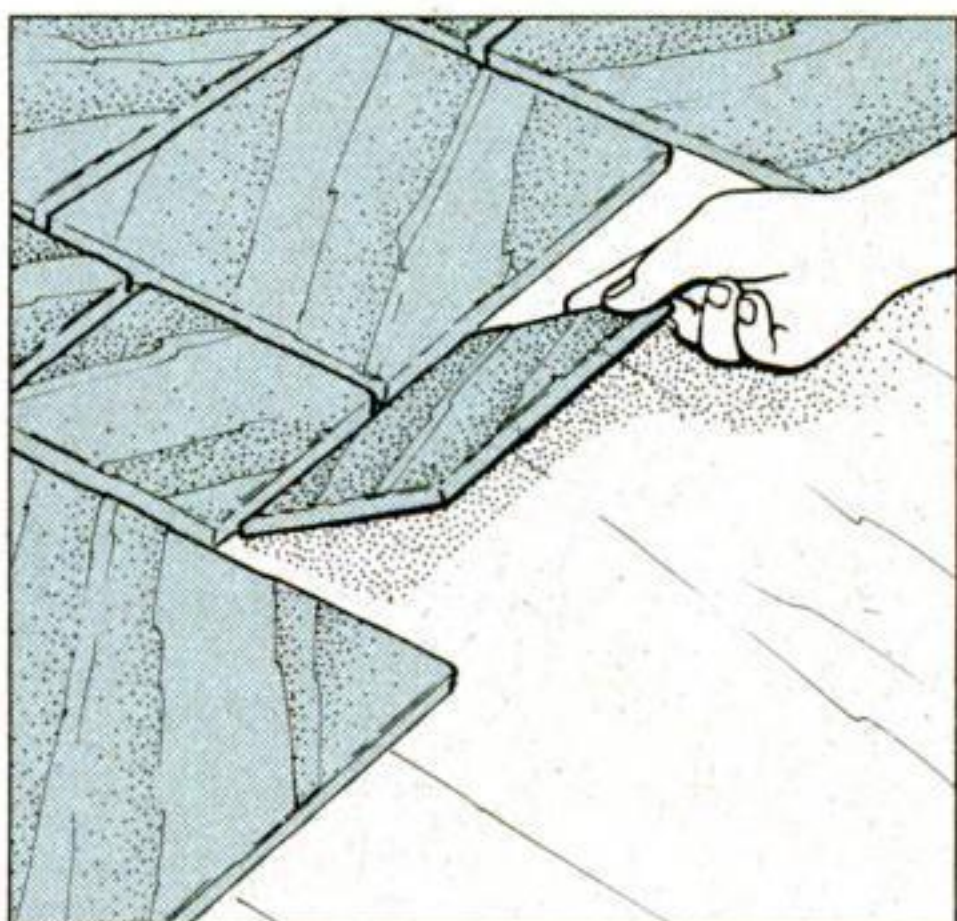
4 Pry tack strips off floor and discard. Resilient floor tiles and linoleum must also be removed to provide stable surface.

watch carefully to see if the floor “gives” under the weight. If the floor is rigid, you can proceed to the next step. But if it’s bouncy, you’ll have to strengthen the structure below. To do this, go into your basement and locate the floor framing beneath the foyer. Then, plan to increase the strength of the floor by running blocking between the joists on 24-in. centers.

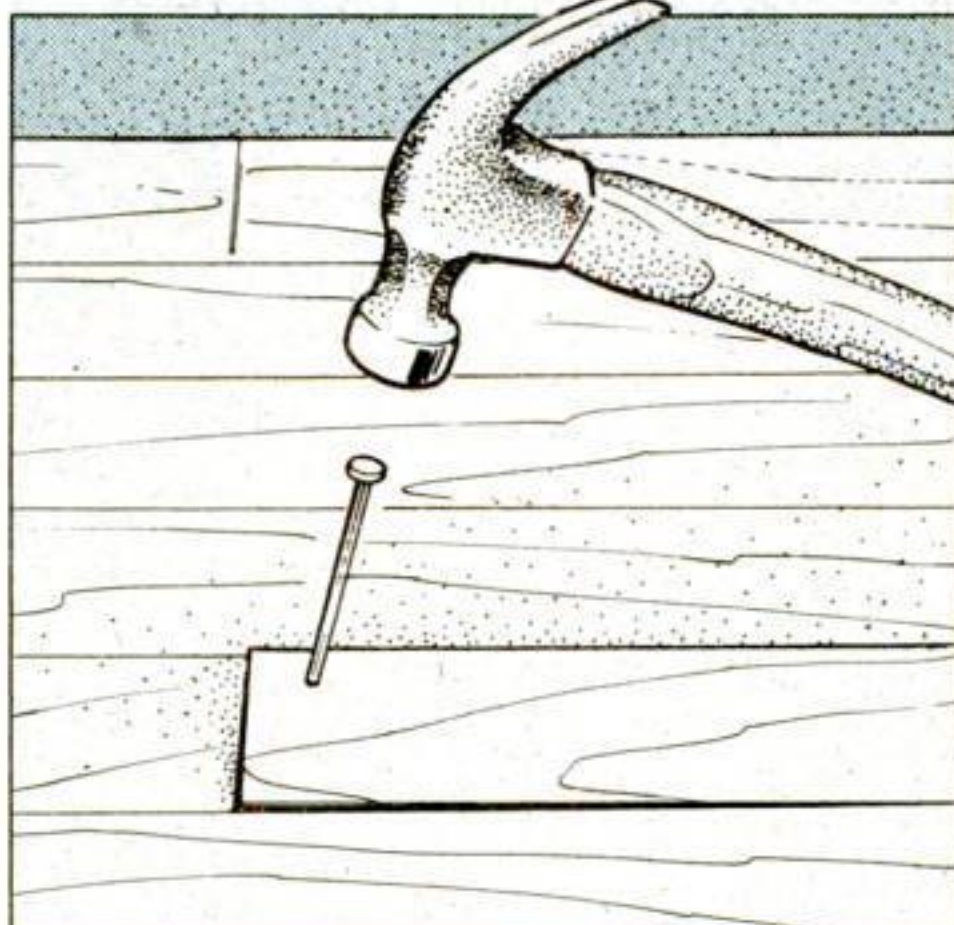
First, cut a block from the same size floor joist material to length, so that it fits snugly between two joists. Mark square lines on the side of the joists at the desired locations. Then nail through the joist into the blocks with 12d common nails. If nailing through the joists is impossible, toenail the blocks in place with 10d common nails. Make sure to hold the blocks to the square lines, and tight against to the underside of the floor above.

Install blocks on 24-in. centers between all of the joists in the foyer. Secure the blocks with joist hangers. Then, nail down through the floor into the blocks with 8d common or box nails.

Your last preparation task is to cut off



10 Lay out tiles on dry floor to match manufacturer’s pattern or one of your choice. Be sure to balance perimeter tiles.

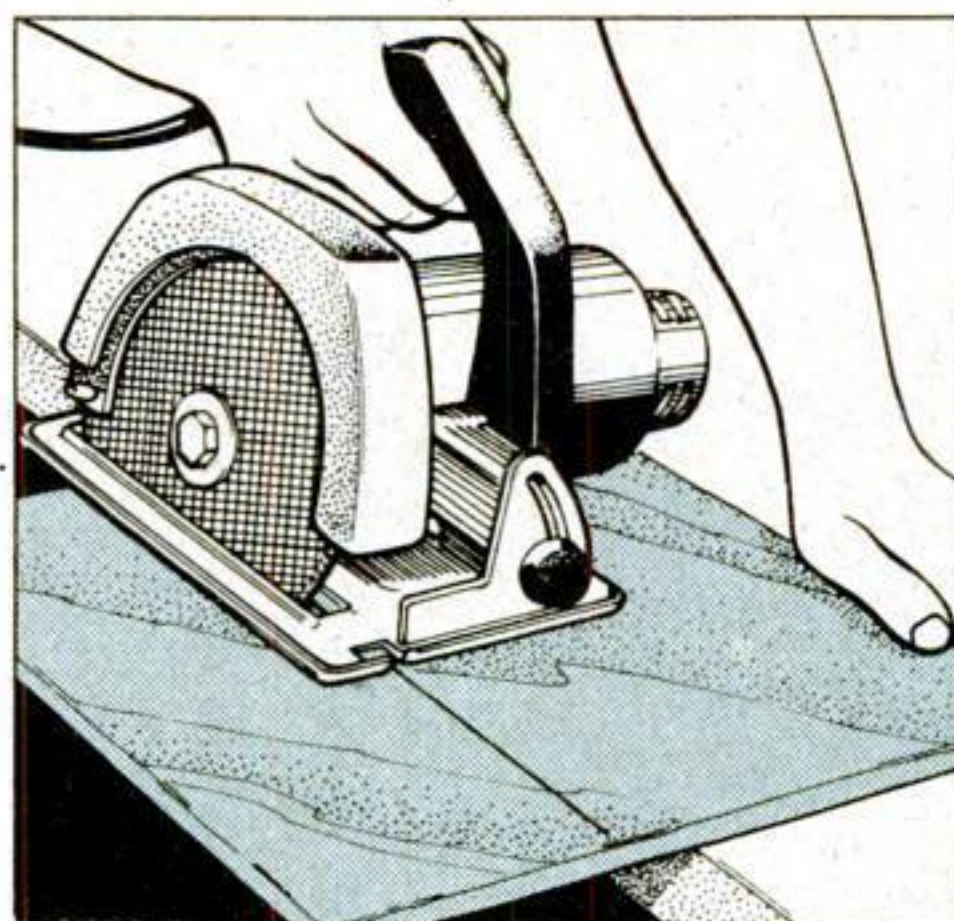


5 Be sure to renail any loose subfloor boards or sections of plywood subfloor panels. Use 8d common or box nails.

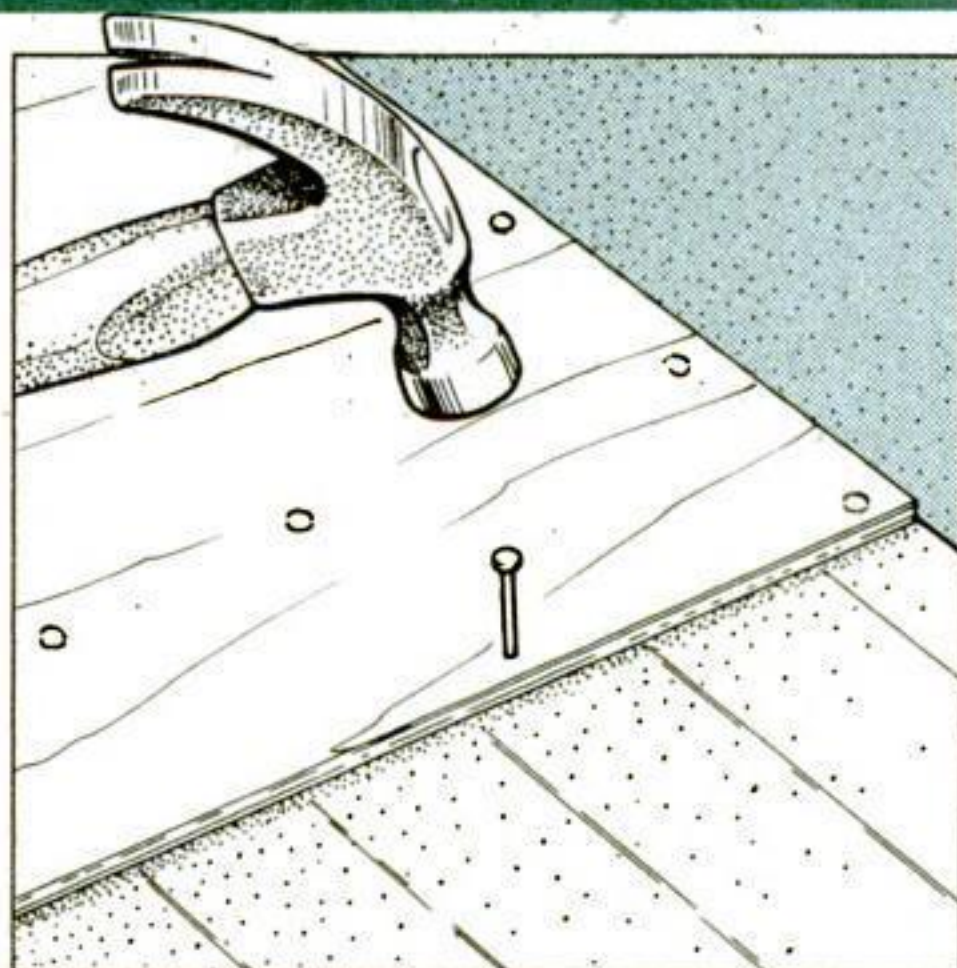
the bottoms of any door casings so the tile will fit underneath. First, place a piece of flooring next to the casing and scribe a line on the casing. At a doorway to an adjacent room, continue the line onto the jamb, stopping at the door stop. Cut the casing with a handsaw, keeping the blade to the waste side of the line. Test to be sure the flooring will fit below the casing with $\frac{1}{16}$ in. to spare—for the thickness of the mastic. Cut age that’s usually involved and it’s the best way to achieve a sound surface.

Layout

Begin by establishing the centerpoint of the room. Measure the distance from one wall to the opposite wall, at both ends of the room. Place a mark on the floor at the halfway point between the walls, then make a similar mark on the floor at the other end of the room. Strike a chalkline between your two marks. Then find the center of your line. Place one edge of a framing square on the chalkline at the center and mark a pencil line along the blade. Lengthen this line—from wall to wall—by snapping an-



11 Use a circular saw and masonry blade to cut perimeter tiles. Be sure to wear eye protection and respirator while cutting.

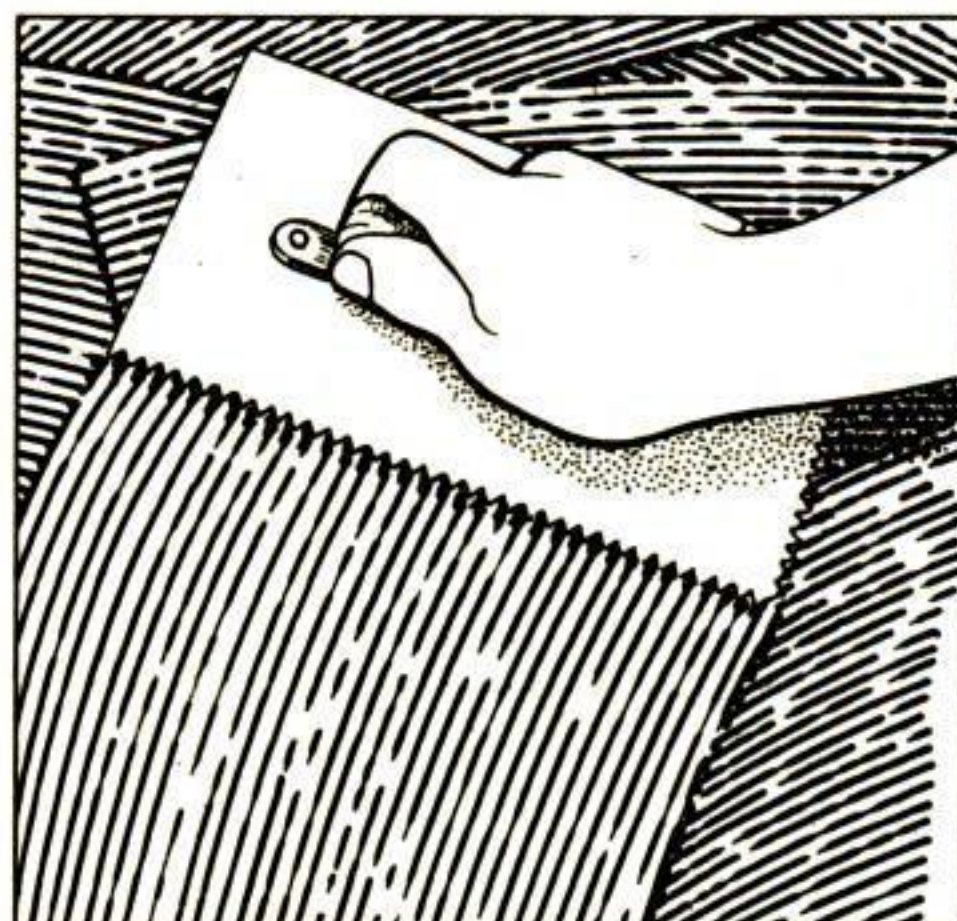


6 In most cases it’s best to cover subfloor with underlayment plywood. Install with flooring nails driven in 4-in.-sq. pattern.

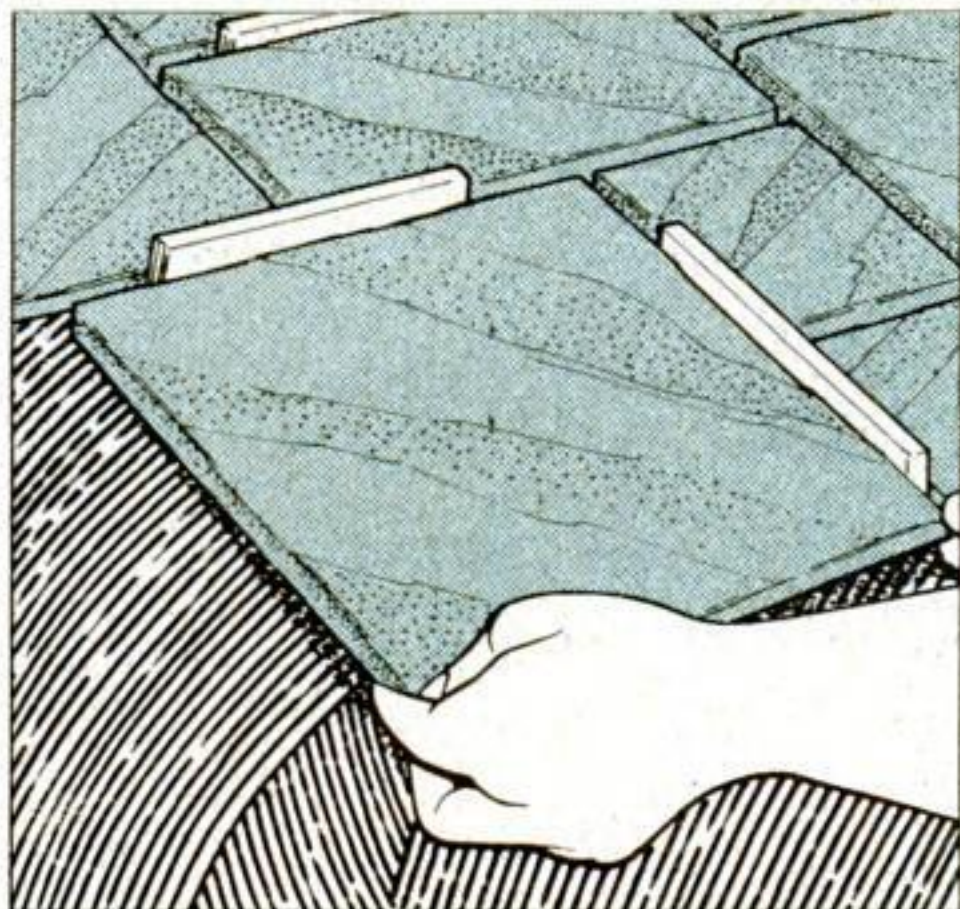
other chalkline perpendicular to the first one. Use your pencil mark as a guide.

With these reference lines in place, open a package of tile. Usually the manufacturer will supply a drawing of a “random” pattern. We followed their suggestions. But feel free to create a pattern of your own. Keep in mind that traditional methods call for grout lines that are $\frac{3}{8}$ to $\frac{1}{2}$ in. wide, though you can reduce or enlarge this spacing for special effects. Scatter tiles of a different color to maintain a random appearance.

To achieve your final layout, cut small wood spacer blocks that match the thickness of the grout joint you prefer. We used $\frac{3}{8}$ -in.-wide joints. Beginning at your reference lines, lay the tiles across the floor in both directions. Slide the wood spacers between the tiles to maintain straight, even grout lines. Adjust the tiles as necessary to make the borders as uniform as possible. Once all the full tiles are in place, and you like the pattern, measure the pieces that are required to fill in the floor. Cut the tiles with a circular saw and masonry cutting



12 Apply mastic in small sections using notched trowel held at 45° angle. Use a sweeping motion to get best coverage.



13 Set tile into mastic and press into place with slight twist. Use wood spacer blocks to maintain uniform grout spacing.

blade, being sure to wear goggles and a respirator, as the dust from the slate is noxious. If you can, do all of your cutting outdoors.

When satisfied with the fit of all tiles, pick them up and lay them out in the same pattern in an adjacent room. By doing this, you can avoid searching for the tile you want after you've applied the mastic to the floor.

Mastic

Begin in one corner, spreading the mastic in a 2- to 3-ft.-sq. section. Hold a $\frac{1}{4}$ -in. notched trowel at a 45° angle to the floor, and work the mastic onto the floor with a sweeping motion. Press the appropriate tiles firmly into the mastic with a slight twisting motion. Place your spacer blocks between the tiles to maintain straight and even grout lines, and remove them once the tiles are down. Work backward toward an open room or doorway to avoid kneeling on the tiles. Continue spreading the mastic and installing the tile until everything is in place. Allow the tiles to set for 24 hours before continuing.



16 When grout is dry to touch, sprinkle sawdust on tile and rub with burlap cloth. This removes residue from grouting job.



14 Let mastic dry, then fill joints with grout using pointing trowel. When voids are filled, smooth surface with trowel.

Grout

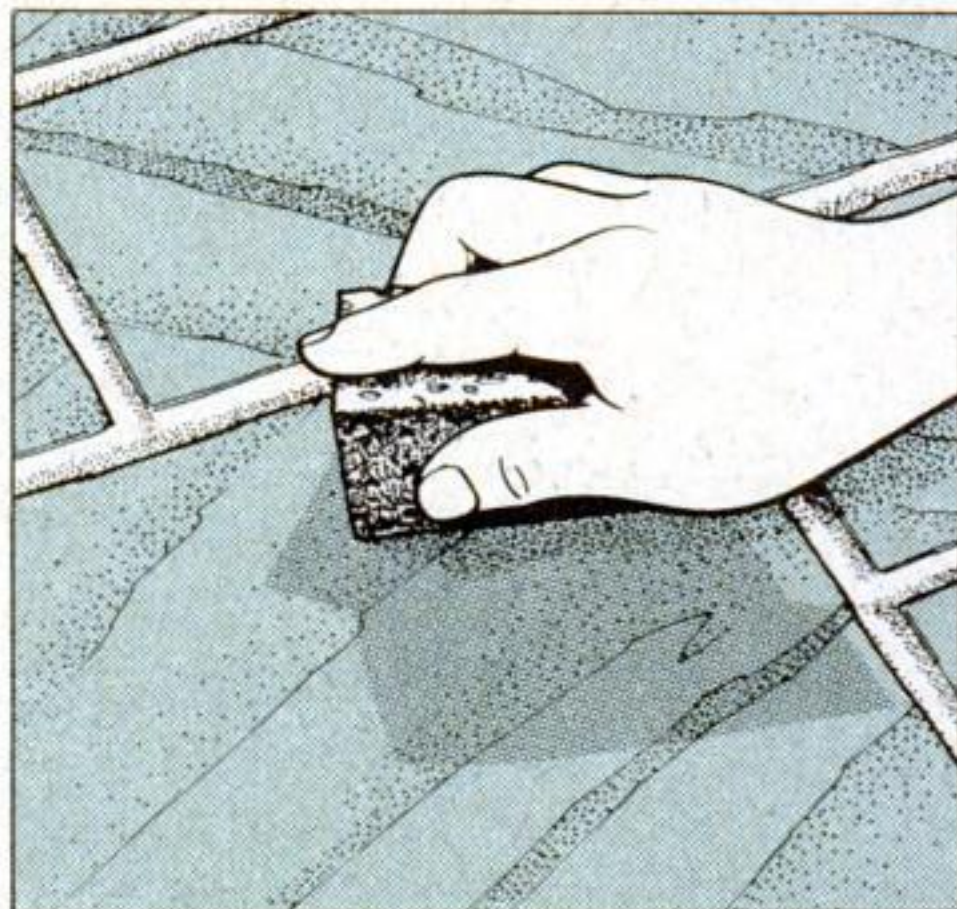
Begin by cleaning all joints and the surface of the slate with a damp cloth. Then, read the mixing direction on the grout container. Keep in mind that the Building Stone Institute recommends the use of a latex grout for slate floors. Slowly add water to the grout while mixing until it obtains the texture of damp sand. Then carefully begin working the grout into the spaces between the tiles with your flat pointing trowel. Be sure to fill all of the spaces completely, then smooth the surface of the grout with the trowel. As you work, clean the grout from the adjacent slate surfaces with a sponge and clean water. Change the water often, and rinse the sponge frequently.

Be sure to clean the tile as you go, before the grout has a chance to dry. If the grout dries on the slate you can only remove it by washing the surface with an acid bath, so try and avoid this step if you can. Be familiar with the open time of the grout, and mix only as much as you can use in the allotted time.

After the grout is dry to the touch,



17 If you want to seal the floor, wait 30 days then brush on a thin coat of commercial sealer. Let dry and apply second coat.



15 While grouting, keep surface of tiles clean. Wipe with damp sponge to prevent grout from hardening on surface.

sprinkle sawdust over the tile. Then rub the surface briskly—in a circular motion—with a clean burlap cloth. Let the joints harden for three days before you walk on the floor.

At this point, wash the floor again with clean water and wipe it dry. If you still have grout stains on the floor, you will have to resort to the acid bath mentioned earlier.

Acid bath

Begin by saturating the joints with water, to prevent the acid from penetrating the grout. Then, mix one part muriatic acid to nine parts water. Be sure to wear rubber gloves and goggles for this whole operation so you won't get burned. Wash the surface of the slate thoroughly, but don't work the solution into the grout. After the floor is clean, wash the floor several times with clean water to neutralize the acid.

It is not necessary to seal the slate, but many people choose to apply a chemical sealer at this point to help protect the grout from stains. Sealers are available in matte or gloss finish, and are easy to apply.

Simply allow the floor to cure for 30 days then apply the sealer to a clean floor with a large cloth or paintbrush. First, apply a thin, uniform coat, then let the floor dry for 2 hours before adding a second coat. Be sure to stay off the floor for a full 24 hours after the second coat, to avoid leaving marks.

When everything is dry, reinstall the baseboard and shoe molding. Set the nailheads, fill the holes and touch up all marked surfaces with paint. Because we were replacing carpet, we had to add a metal trim strip between the remaining carpet and the new slate floor. These inexpensive trim strips are available in a variety of colors and styles at carpet stores.

FM

How To Repair An INCANDESCENT LAMP

BY MERLE HENKENIUS
Illustrations by George Retseck

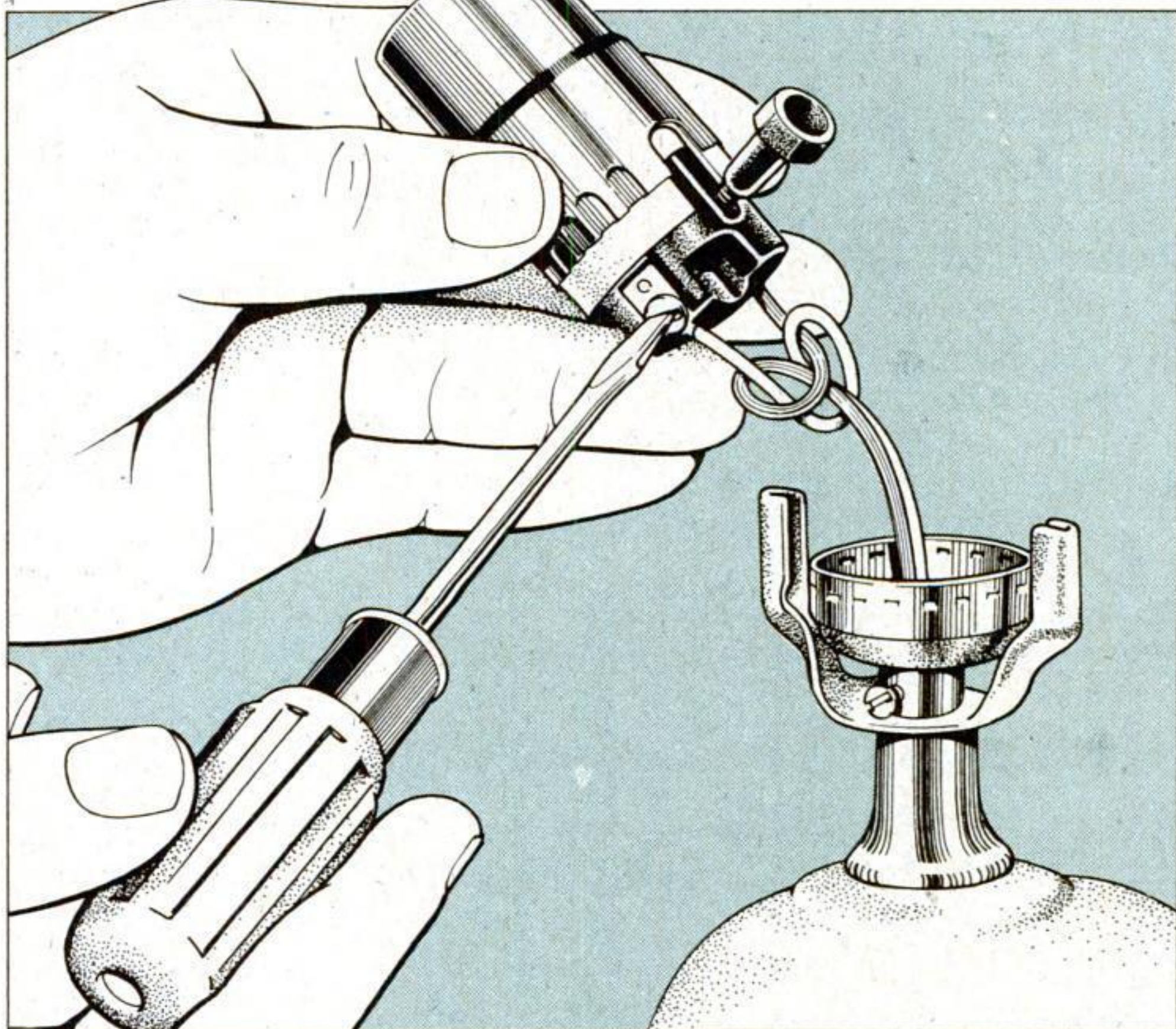
INCANDESCENT lamps are basically all alike. Aside from stylistic differences, every lamp includes the same electrical components—a plug, cord, socket and switch. These are the only components that can wear out in a lamp, and each is a quick fix. If you have a lamp that has kept you in the dark too long, take heart in knowing that you can replace every part in it for around \$10 and about 1 hour of your time.

Troubleshooting a lamp

When trying to locate a defective component, don't overlook the obvious. Always check the light bulb first. If you are satisfied that the bulb is not the problem, then go on to the plug. Look for any char marks that might suggest a faulty connection.

If the plug is a screw-terminal type with a cardboard face plate, pry the face off and look for loose wires. Also check for frayed insulation or any apparent break or split in the cord.

If the plug and cord seem undamaged, look to the socket and switch. Sockets and switches either work or don't work. There isn't much in between. If your lamp has a line switch attached to the cord, you can replace it without touching the socket. Most lamp switches, however, are contained in sockets. Short of using a voltage tester to investigate further, you should probably just replace the socket and switch and be done with it.



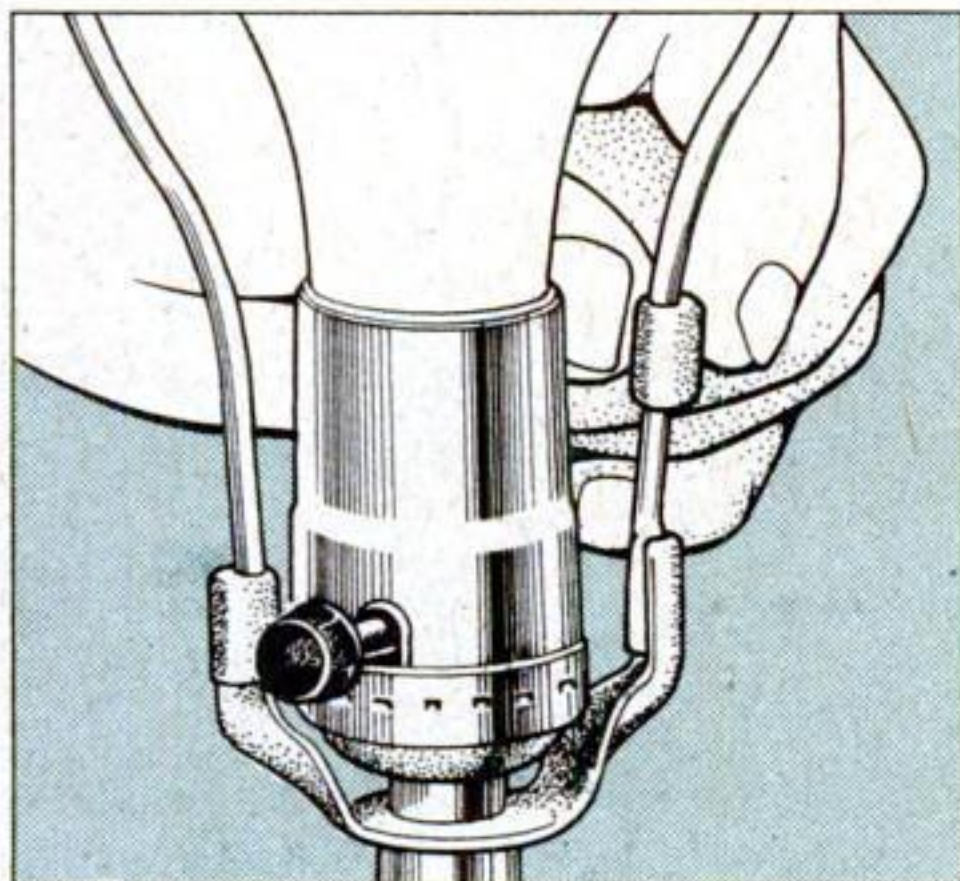
Dismantling a lamp for repair

Taking a lamp apart is not difficult. It's a simple progression from shade to plug. The amount of dismantling you do will depend upon how much repair your lamp needs.

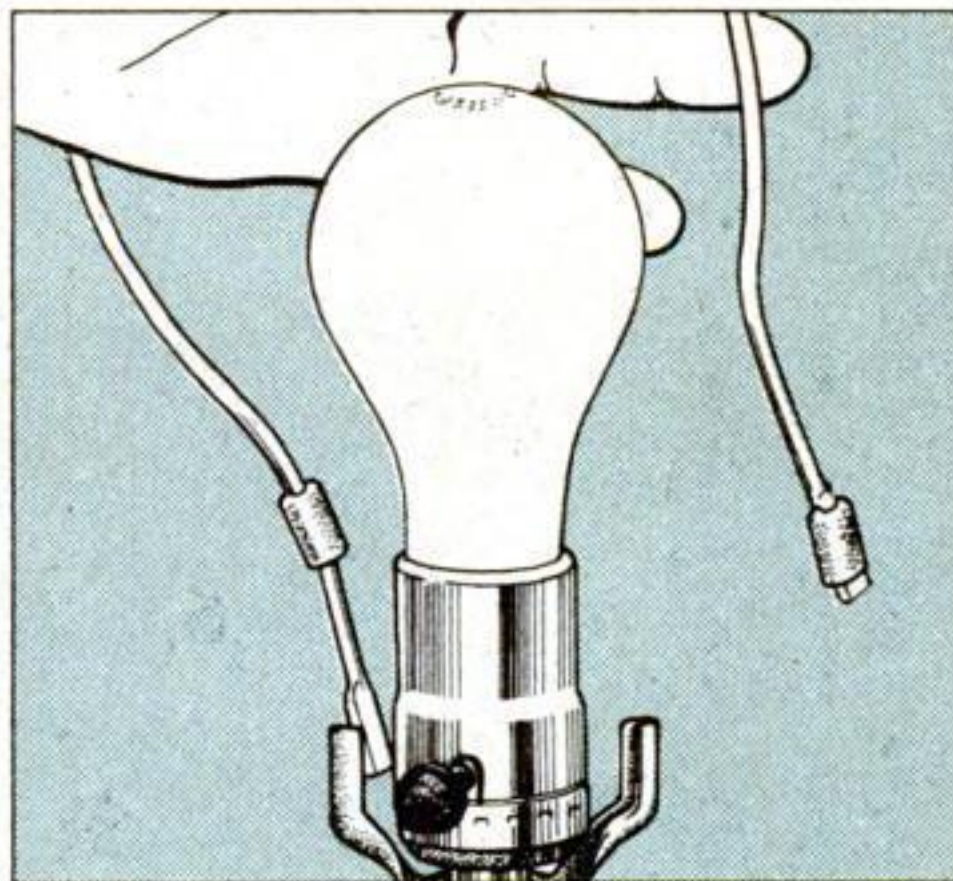
Start by undoing the lamp shade. Simply loosen the threaded cap, called a finial, and lift the shade up and off. Next, remove the bridged wire sup-

port, called a harp, by sliding upward the two metal ferrules on the harp bracket. Squeeze and lift the two halves of the harp until they come free. You will then be able to remove the socket.

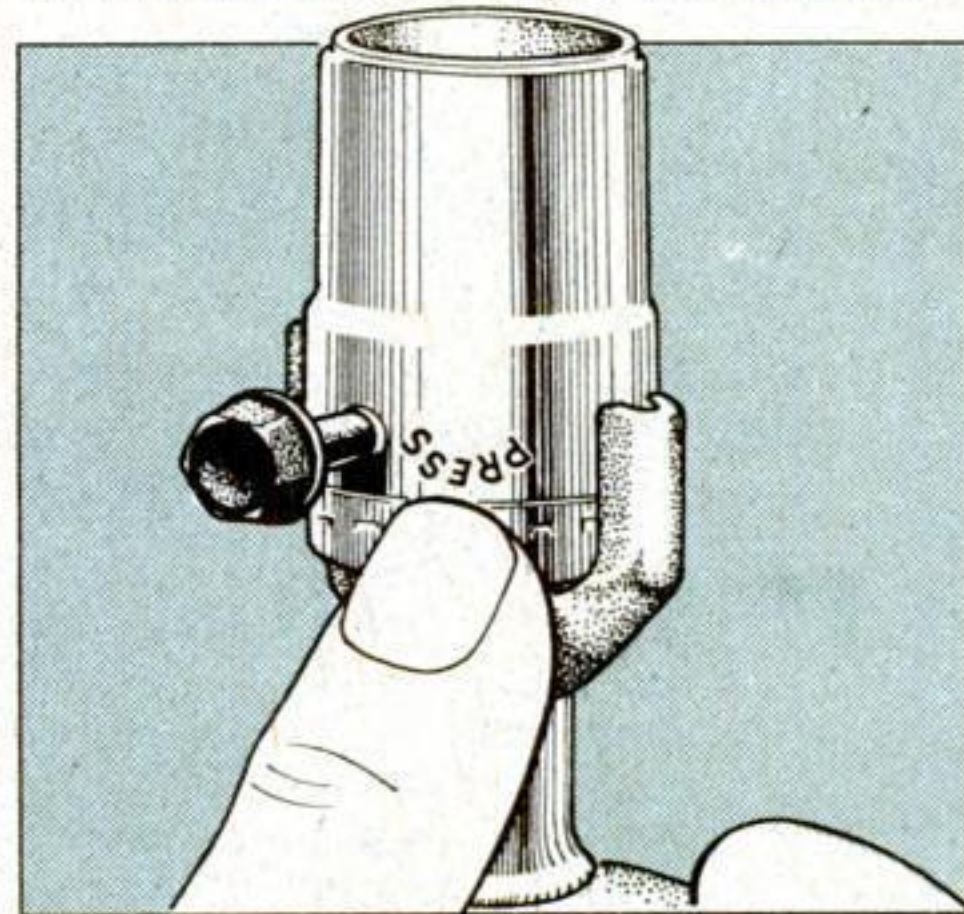
Each socket has four elements—an outer shell, insulating sleeve, socket and socket cap. To separate the outer shell from the cap, press in and pry up where you see PRESS stamped into the metal shell. If you can't free the shell



1 The harp supports the lamp shade and is joined to socket cap with two small ferrules. To free the harp, lift up the ferrules.



2 To remove the harp, squeeze the sides together and lift off the base. If harp is stuck, pliers may be required to free it.



3 To remove socket, press and pull up where you see word PRESS on socket shell. If stuck, pry up with small screwdriver.

with your fingers, use a small screwdriver to pry it off. By removing the outer shell, you expose the insulating sleeve, socket and electrical terminals.

With the shell and sleeve removed, pull an inch or two of cable through the socket cap. Loosen the terminal screws on the socket and pull off the wires. Then use a small screwdriver to loosen the setscrew on the socket cap. Undo the Underwriter's knot in the cord and slide the cap off the wire. At this point, you will be ready to rebuild your lamp.

Replacing plugs and cords

Older cords with fabric covers should be replaced as a matter of course. Their rubber insulation and silk inner sleeves become hazardous with age. Zip cord is now the only cord approved for lamps by the NEC (National Electrical Code). Zip cord is stranded copper wire molded into flexible plastic insulation that offers long-term protection. The plastic insulation may be colored or clear and is ribbed on one wire and smooth on the other. The ribbed wire is the neutral wire—the smooth is the hot wire.

If your lamp cord was previously too short, now is the time to make it longer—simply buy the length you prefer. To avoid having to negotiate your new cord through the base and the threaded tube, tape your new cord to the old cord at the top of the lamp and pull them both through the lamp base. Once through, tie an Underwriter's knot (Fig. 7) in the socket end of the cord and install a plug on the other end.

The self-piercing plugs made for zip cord are literally a snap to use. They come in two pieces: a plastic body and a pronged insert. All you do is slide one end of the zip cord through the body and insert the unstripped cord into the prong slot. Make sure the smooth (hot) wire goes to the smaller prong, and squeeze the prongs together. Then push the prongs into the plug body until they snap into place. A small spike on each prong pierces the insulation and makes contact with the stranded wire.

Installing an in-line switch

When you open an in-line switch, you will immediately see how it works. One

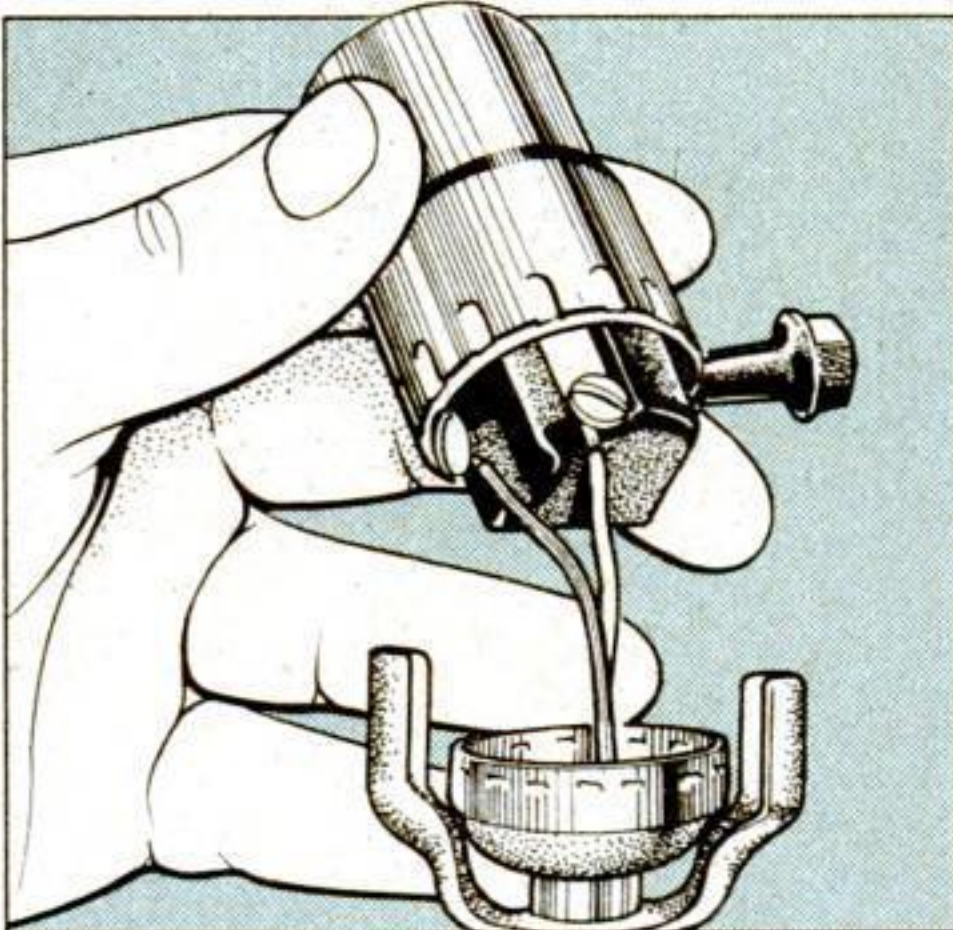
wire in the cord passes through uncut and the other is interrupted by the switch. Start by cutting the positive (smooth) side of the zip cord and peeling back about $\frac{3}{4}$ in. of this cut wire.

Lay the cord in the switch slot as shown in Fig. 8. Then press the separated wire into its slot and tighten the two halves of the body together. The switch prongs will automatically pierce the cord and make contact.

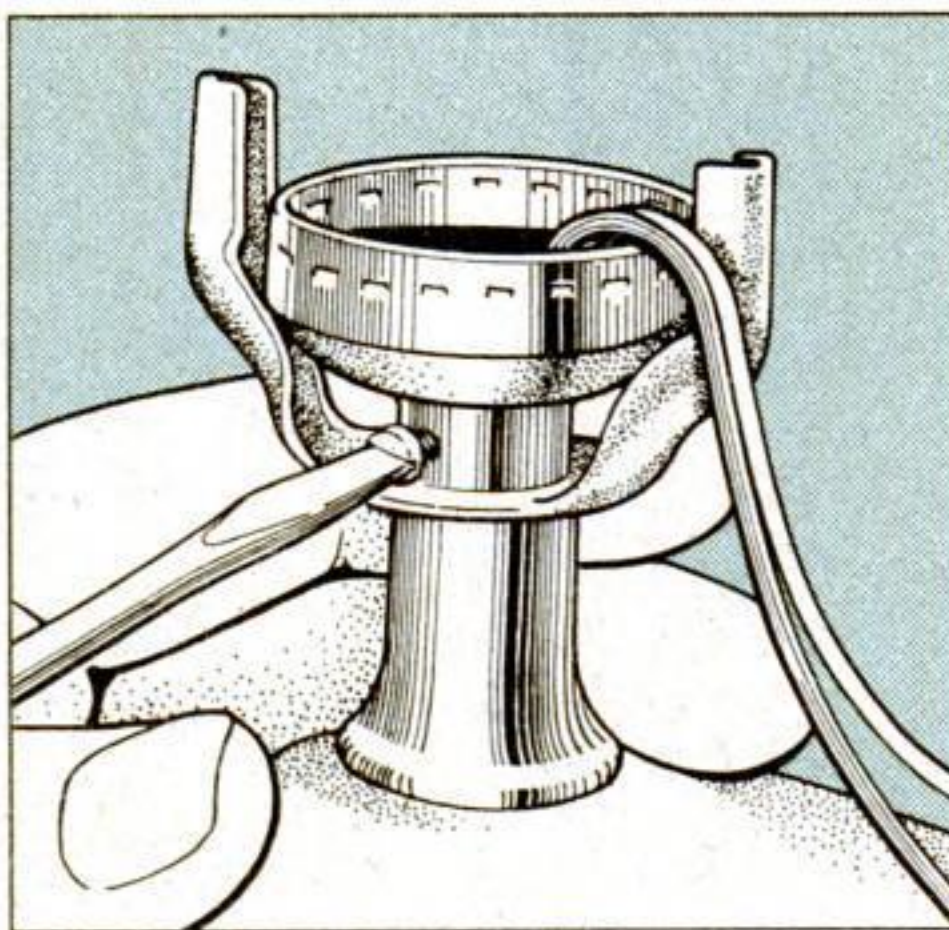
Replacing a lamp socket

To replace a lamp socket, start by pulling apart the two wires in the cord. You will need about 2 in. of separated wire. Strip $\frac{5}{8}$ in. of insulation from each wire. Slide the old harp bracket and new socket cap over the cord and tie the wires in an Underwriter's knot. Then fasten the socket cap to the threaded tube with the setscrew provided.

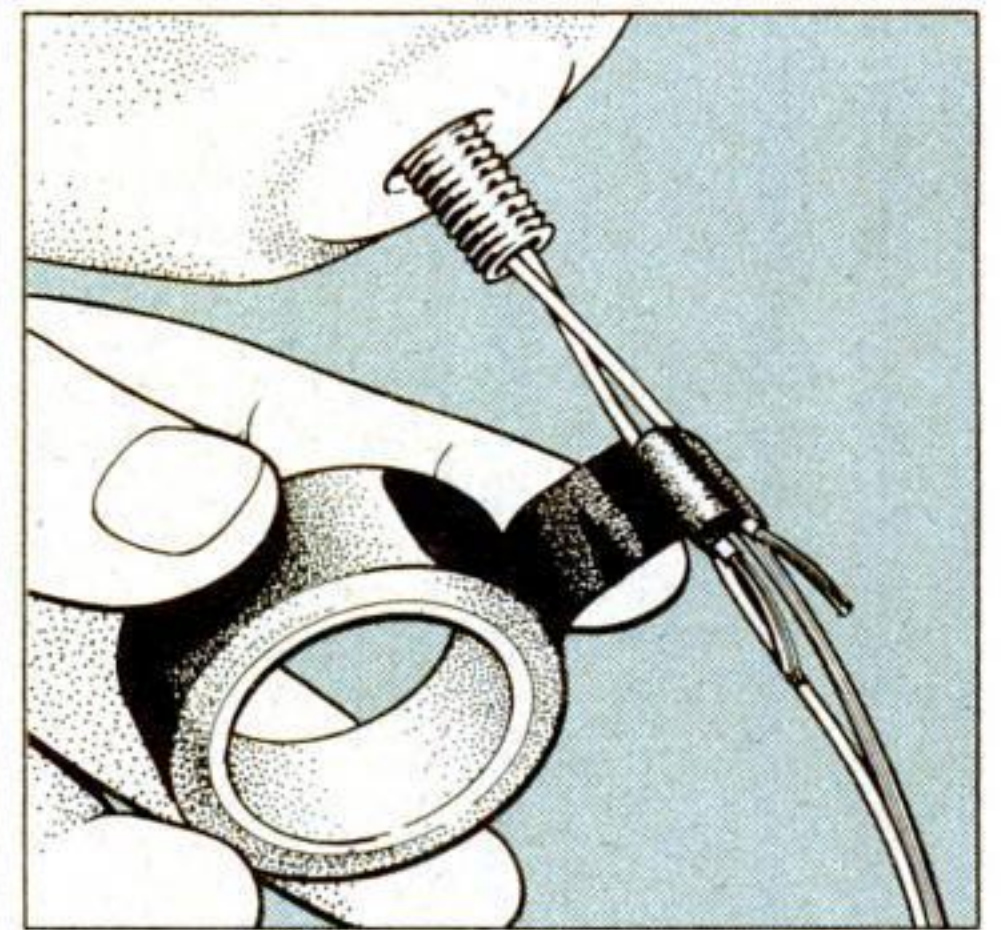
Next, tighten the hot wire around the brass screw and the neutral around the silver screw. Slide the insulating sleeve and outer shell over the socket and snap the outer shell in place. Finally, replace the harp, shade, finial and bulb. **FM**



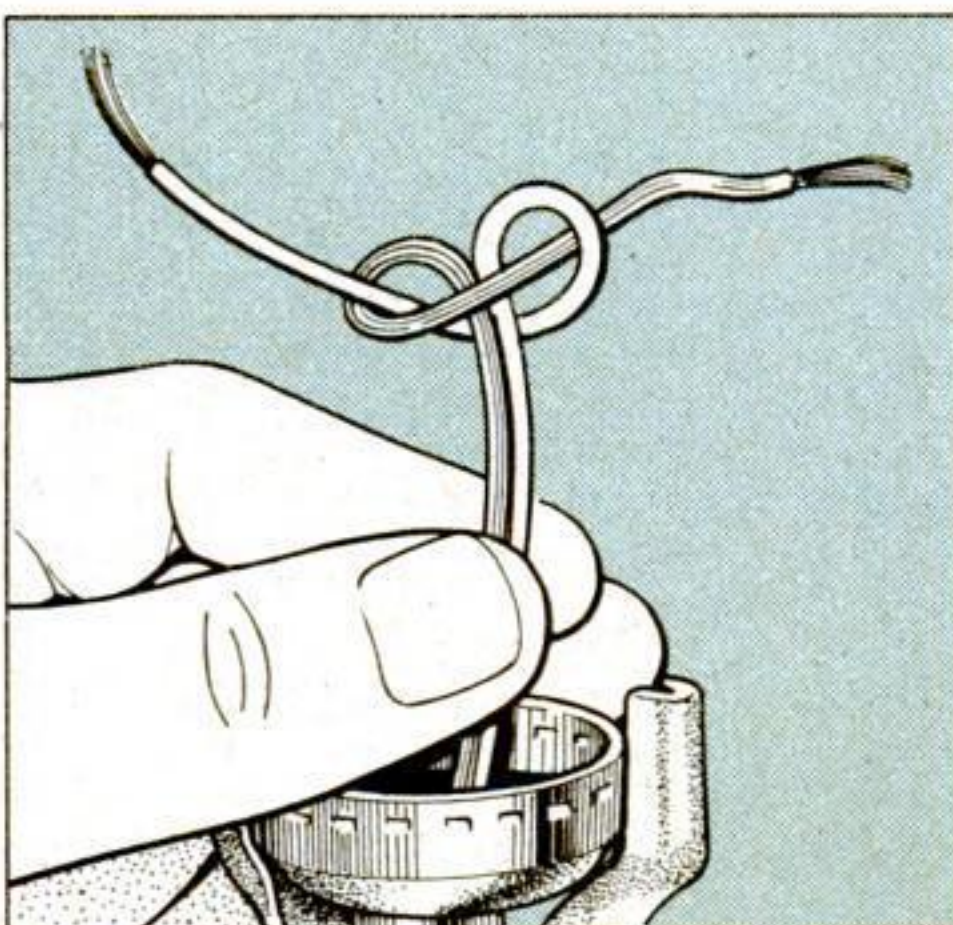
4 To expose the terminal screws, slide up the socket shell and insulating sleeve. Loosen terminal screws and pull off wires.



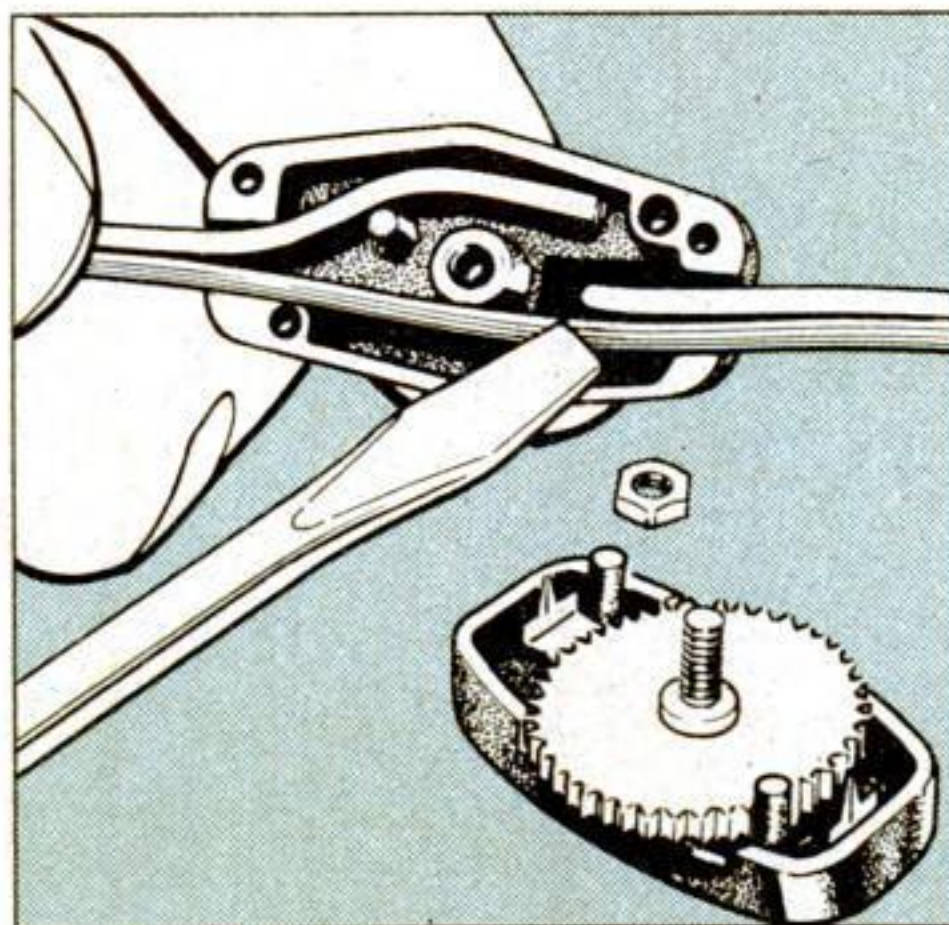
5 To remove socket cap, loosen setscrew and turn cap off threaded tube. Harp bracket and spacer will come off, too.



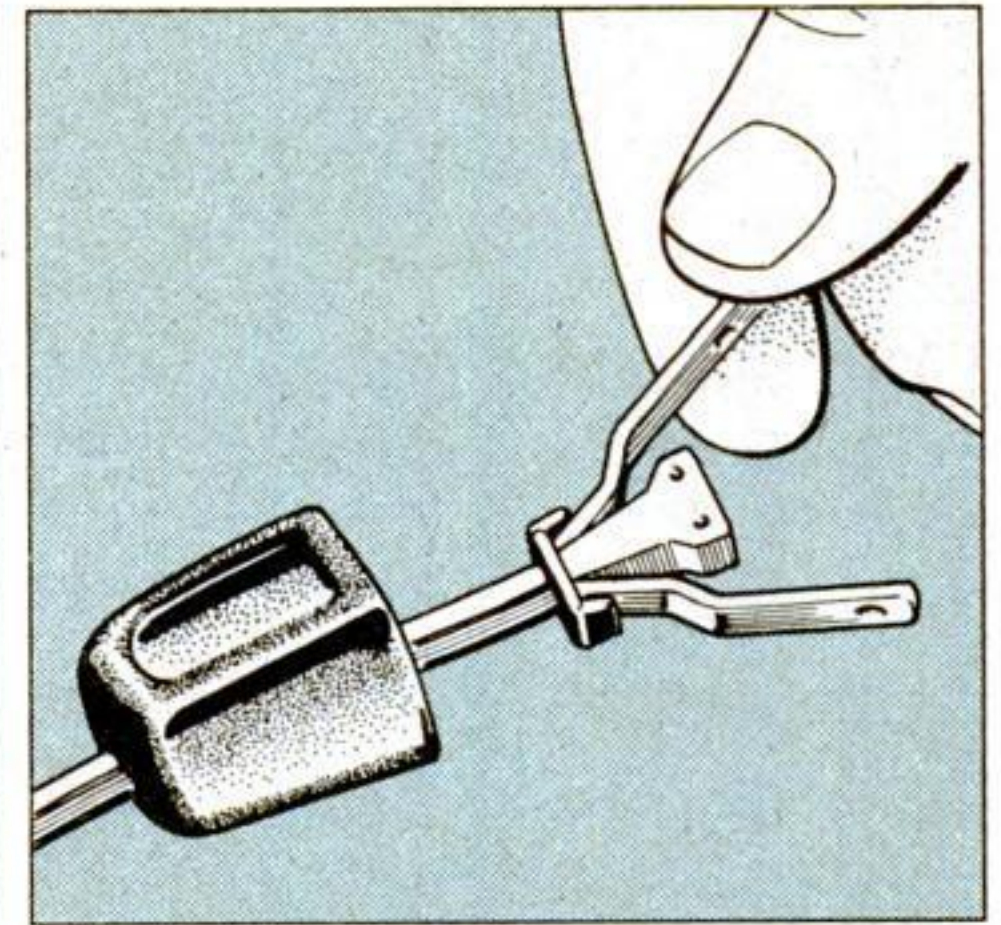
6 To replace the cord, tape end of new cord to socket end of old cord and pull both through threaded tube at base of lamp.



7 To prevent wire from coming off screws if cord is pulled, tie Underwriter's knot in end before attaching to terminal screws.



8 To install in-line switch, cut the smooth, positive wire and press it into place. Then screw switch sides together.



9 To install new plug, feed wire into plug body and slide end into pronged section. Squeeze prongs and snap into body.

Homeowners' Clinic

BY NORMAN BECKER, P.E.

GFI Protection

The electrical system in my house is controlled by circuit breakers. I was recently told to install a GFI circuit for my bathroom. Will this give me any more protection than the circuit breaker that already controls the bathroom outlet? ROBERT HUGHES STONEY POINT, NY

Yes, it will because they serve different functions. A circuit breaker or fuse will prevent a fire that's a result of excessively hot wires. This is done by automatically interrupting the circuit when the amperage it's carrying exceeds the capacity of the circuit.

On the other hand, a GFI (Ground Fault Interrupter) is designed to prevent a fatal electric shock by interrupting the circuit whenever there's an imbalance in the current between "hot" and "neutral" lines. The GFI will open the circuit when the imbalance is as small as 5 milliamperes. This is $\frac{1}{3000}$ of the current needed to trip a breaker set for 15 amps. A GFI circuit interrupts the power within $\frac{1}{40}$ of a second or less—fast enough to prevent injury to anyone in normal health. At 50 milliamperes ($\frac{1}{20}$ of an amp), it takes only $3\frac{1}{2}$ seconds for a person's pulse to stop.

Hot Water Supply Problem

If I turn on the hot water in my house when someone is taking a shower, they'll get an unexpected cold blast. Can this problem be explained by the small-diameter ($\frac{1}{2}$ -in.) pipe in the heating loop? Or, is it caused by lime encrustation in the heater? The cold water supply pipe is $\frac{3}{4}$ in. dia.

WALTER D. KELLY, JR.
WELLESLEY, MA

It sounds like your hot water is generated by a heating system that uses a tankless coil rather than an oil- or gas-fired tank-type water heater. The problem you describe is common in units where there's a mineral buildup on the inside of the coil. The lime encrustation greatly reduces the effective opening and, even when the pressure is good, reduces the water flow.

The minerals can usually be removed by an acid flush. This, however

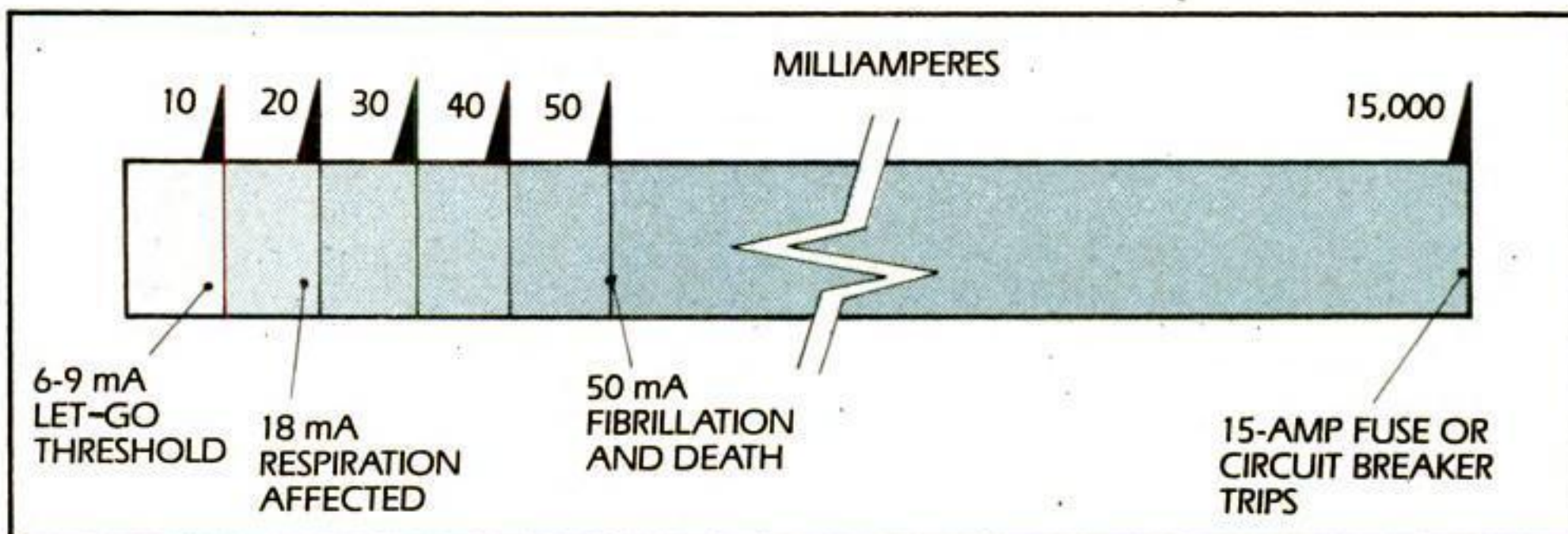


Chart above shows potential effects of amperage levels on humans. A normal 15-amp circuit carries enough current to stop the heart. GFIs interrupt circuit as low as 5 milliamperes.

is not recommended. The coil may be pitted and removing the encrustation could cause it to leak. Your best bet is to replace the tankless coil. Also, the water flow in the $\frac{1}{2}$ -in. pipe is slightly less than half the flow in your $\frac{3}{4}$ -in. supply pipe. The $\frac{1}{2}$ -in. pipe was probably installed to reduce the flow which shortens the time needed for the water to reach the desired temperature. If cold water flows through the coil too rapidly, it would not absorb the required heat.

If after replacing the tankless coil the hot-water flow is less than you desire, I suggest you replace your hot-water system with an oil- or gas-fired, tank-type unit and replace the $\frac{1}{2}$ -in. pipe with $\frac{3}{4}$ -in. pipe.

Warping Doors

Seven years ago I purchased a well-built 30-year-old house. Two years ago I noticed that many of the doors were beginning to warp. The doors are original. Why are they starting to warp now? I don't use a humidifier but I do use the fireplace more than the original owner.

JIM CASELLI
DANVILLE, CA

The warpage is the result of the swelling or shrinking of the doors' edges or faces due to a change in moisture content. Often, the top, bottom or side edges are not painted and consequently tend to absorb or lose moisture faster than the painted sections. If the door faces have not been painted or varnished in 30 years, they too are more susceptible to changes in humidity. With flush doors that have a veneer face, sections of the joint between the facing and the edges sometimes open

exposing the interior to moisture change. Warpage results when the change is greater on one side of the door than the other.

If the interior doors are shut when the fireplace is in use, it's possible that the sides facing the fire will dry faster than the opposite side. Also, because of heat stratification in some homes, doors that are not properly sealed often warp near the top section.

Wash-Off Gloves

When I worked in the painting department of a factory, we used a hand cream product that was applied to our hands before we began work. It dried to a protective film. When the painting was over, we simply washed our hands in water and the paint was removed. I'm now involved in house restoration and would love to find this product.

DORI GRIMSHAW
WINDSOR, CT

Two products that will do the job are: Liquid Glove manufactured by Enviro-Chem, Inc., Box 1086, Walla Walla, WA 99362, and Elmer's Invisible Glove made by Borden, Inc., Box 16700, Columbus, OH 43215.

Liquid Glove comes in a 16-ounce container and costs \$8. Invisible Glove comes in a 3-ounce tube and costs \$3. They're both available at hardware stores and home centers. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH

Calibration Required

I acquired a Kenmore gas range model No. 103.247821 that has a thermostatically controlled (Maid-O-Matic) top burner. The stove is at least 30 years old but has seen very little use. After cleaning, the stove looks new and is now in daily use.

The only problem is that the thermostatically controlled burner is out of adjustment. Can you tell me how to recalibrate it?

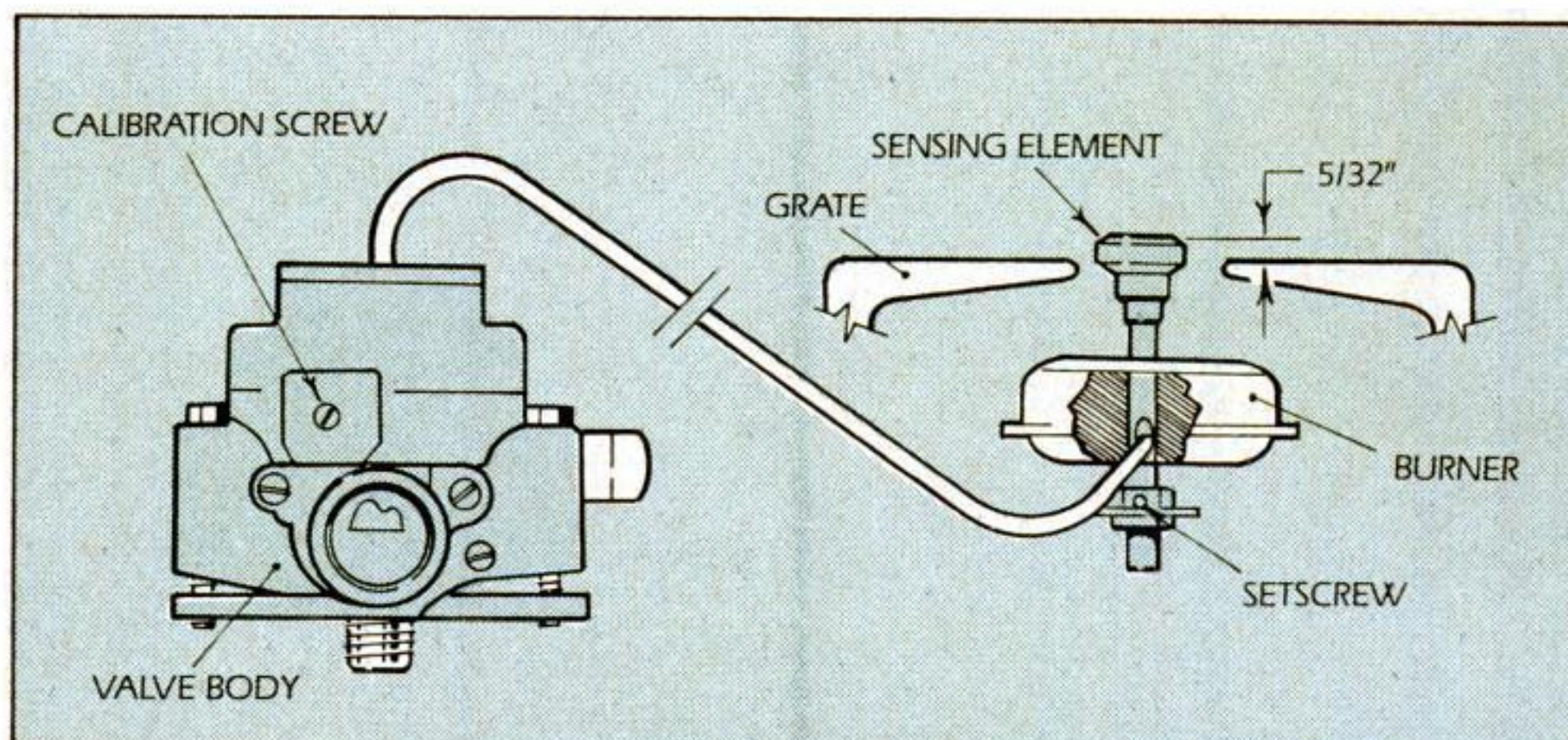
RALPH BULLOCK
KOSSE, TX

The Maid-O-Matic burner uses a sensing element in the center of the burner to monitor the temperature of the contents of a pot. It automatically raises or lowers the flame to maintain the required temperature.

Before attempting a recalibration, be sure to check that the sensing element is adjusted properly. Both the top of the sensing element and the bottom of the pot it comes in contact with must be clean. The top of the sensing element should protrude $\frac{5}{32}$ in. above the burner grate. To adjust this height, first remove the grate, aeration pan and burner. Loosen the setscrew located in the sensing element and raise or lower the element head until it's at the correct distance above the grate. Then, tighten the screw and reassemble.

To check the thermostat control, place a 3-quart-capacity, flat-bottom aluminum pan on the burner and fill it with 1 quart of water. Then, position a mercury thermometer $\frac{1}{4}$ in. from the bottom of the pan and $1\frac{1}{2}$ in. from the center. Use a piece of aluminum foil as a cover for the pan and support for the thermometer. Next, turn the control to LITE to ignite the burner. Adjust the control to 175° and allow the unit to operate for 10 to 15 minutes or until the water temperature becomes stable. The reading on the thermometer should fall within 5° above, or 10° below, the dial setting.

If your reading is outside this range you'll need to recalibrate the thermostat. Begin by turning the dial to the OFF position and pull the dial and chrome bezel up and off the control. Find the calibration screw located to the left of the knob shaft on the valve body. Use a screwdriver to turn the



To check a thermostatically controlled burner, make sure the element top is $\frac{5}{32}$ in. above the grate. Adjust the valve calibration screw so the pot temperature conforms to dial temp.

screw clockwise to lower the temperature, or counterclockwise to raise it. Note that each notch on the calibration plate is equal to a 10° change. After making the adjustment, replace the dial and bezel and recheck the temperature.

Semi-Annual Clog

About 5 years ago I purchased a Gibson gas dryer model No. DG18A9FJFA. Ever since then I've had lint-accumulation problems. The lint collects around the blower and in the ductwork and it's necessary to clean out the system twice a year. The lint screen is cleaned regularly although there's rarely any significant lint buildup to remove. Do you have any suggestions?

RAYMOND HOWARD
BUFFALO, NY

Because of the lack of lint in the filter I suspect that it may be plugged. This situation can worsen if you use a product that gives off vapors to reduce static-cling. These conditioners plug up the fine holes in the lint filter reducing the ability of the dryer to pull through the correct amount of air. The lint laden air is then drawn around the filter and the lint accumulates in the exhaust duct system. To check the filter, remove it from the machine and hold it up to a bright light. If it's a cloudy white color and you can't see through it, then it's restricted.

For a temporary fix, you can try cleaning the filter in a solution of mild soap and warm water. The factory cor-

rection is to replace the filter. The replacement filter has the same part number as your original but will have a wider mesh making it harder to plug up. This does, however, allow more of the fine lint particles to pass through and you'll still have to clean the dryer periodically. The filter (part No. F-140-877-000) costs about \$11 and is available at any authorized Gibson parts distributor in your area.

When installing the new filter, check that the filter housing is not warped and the new filter fits properly. If you have problems installing it, I suggest you call a Gibson service technician to have the job done.

PM

Service Tip

Those of you who own Montgomery Ward home laundry appliances can get service manuals for your specific model washer or dryer. Each manual includes helpful information on troubleshooting and repair with illustrations to make the job easier. A parts list is found in the rear of most manuals to help when ordering replacements. For more information write to Montgomery Ward Parts Distribution Center, 5750 McDermott Dr., Berkeley, IL 60163, or call (800) 328-6531.

If you have a problem with any appliance, send your question, with the model and serial numbers to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

Save Gas, Save Engine with Slick 50

The following introduces one of the most fully tested and proven gas saving, friction-reducing engine treatments ever to reach the market!

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"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

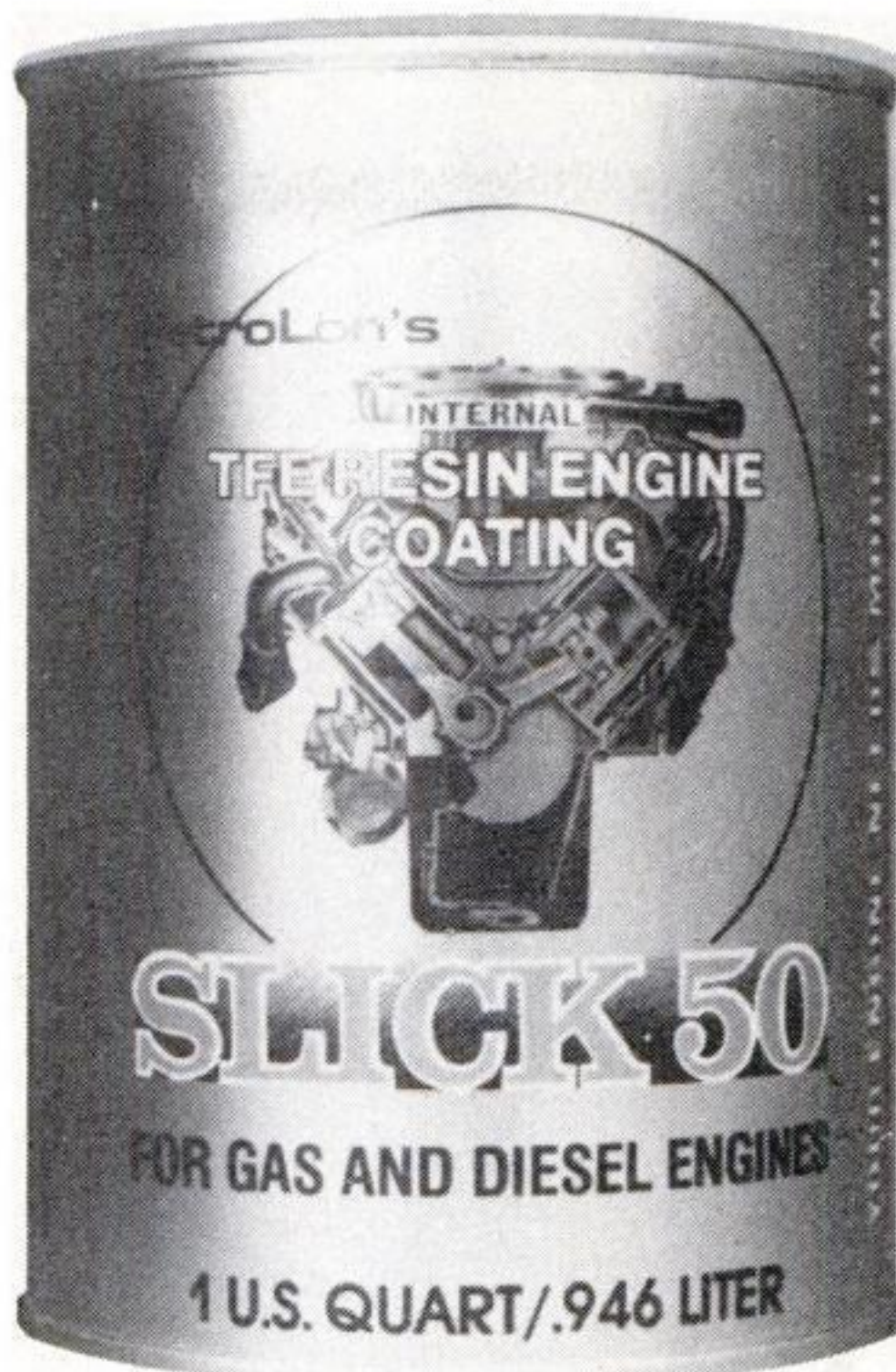
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

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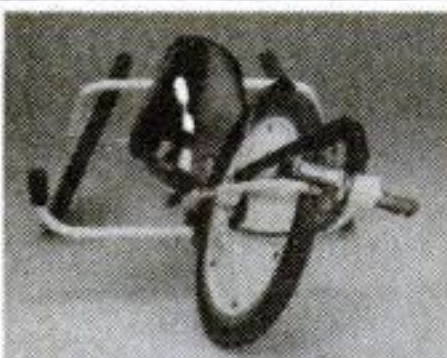
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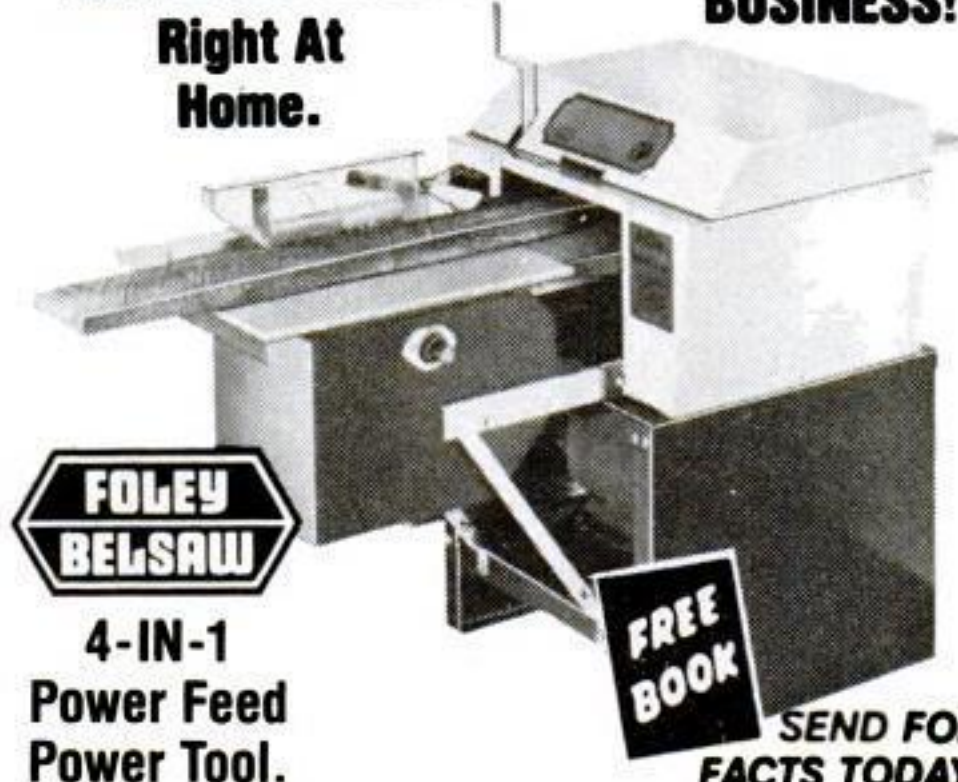
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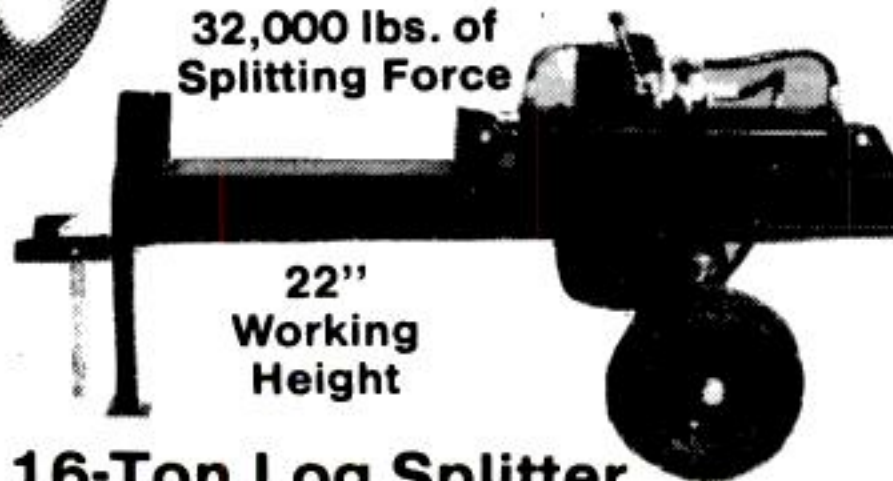
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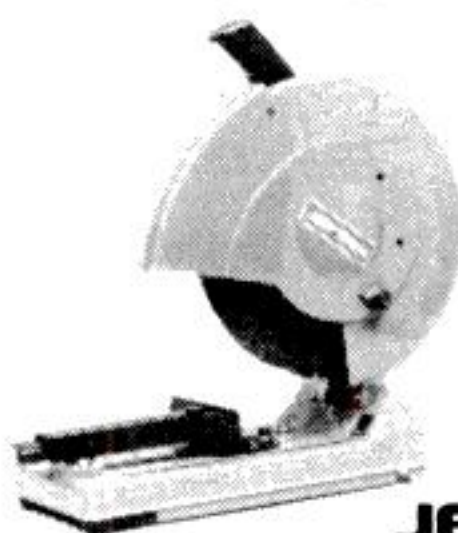
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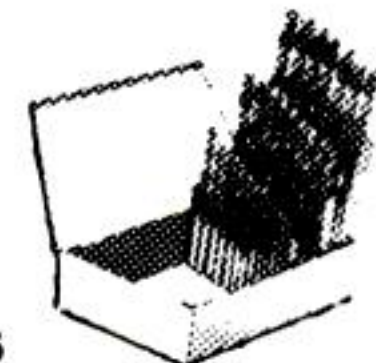
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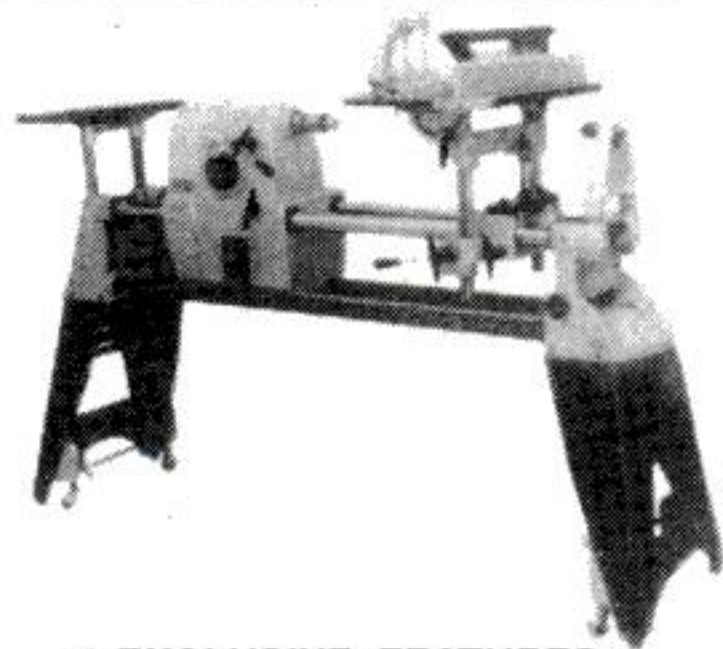
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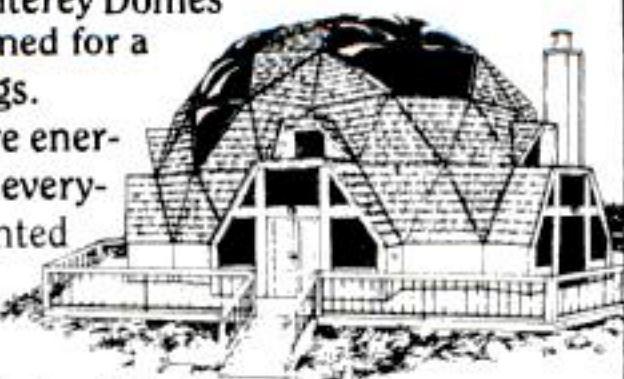
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The Only Car Wax in Colors.

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KolorKey's patented formula is made with only the finest grade of pure carnauba and contains absolutely no abrasives. KolorKey is safe on all types of car finishes.

Covers Tiny Scratches.

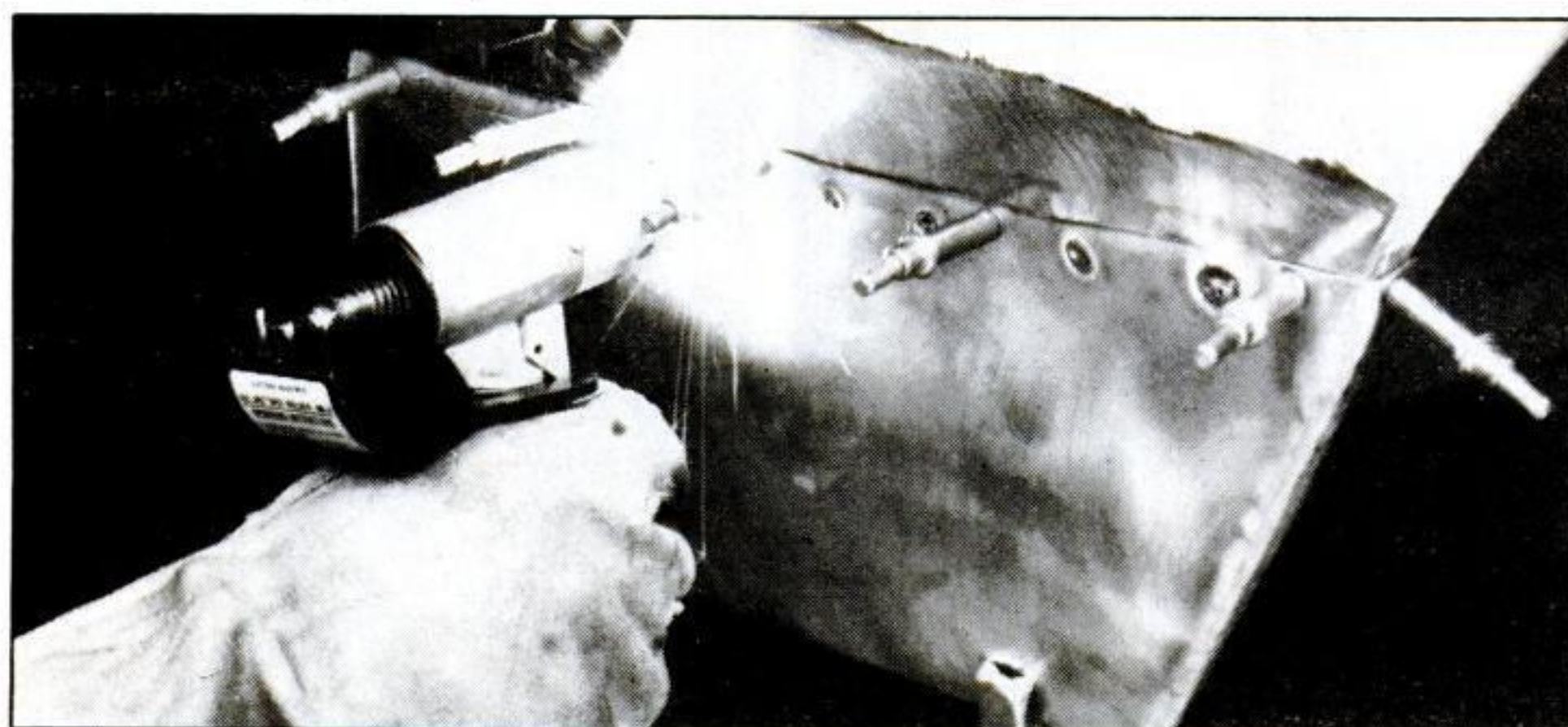
KolorKey removes those tiny "haze" or "spiderweb" like scratches on all colors, even on black.

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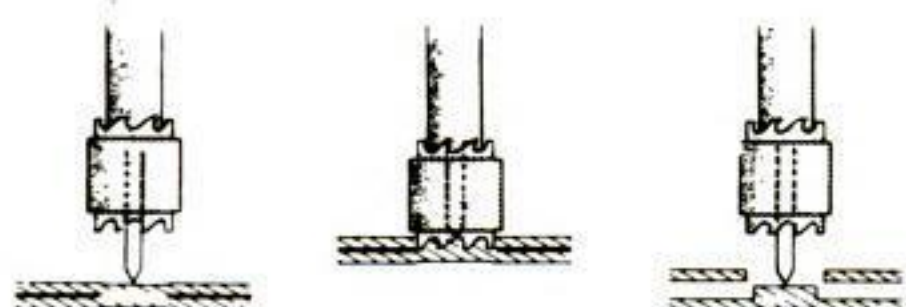
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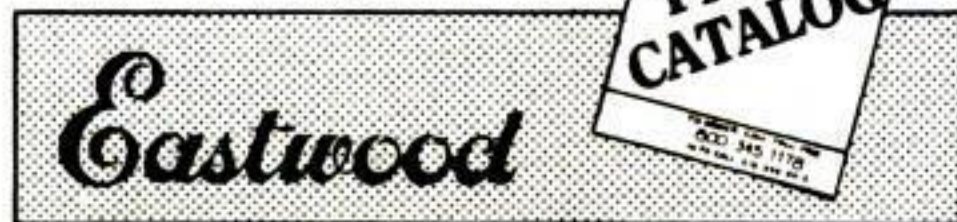


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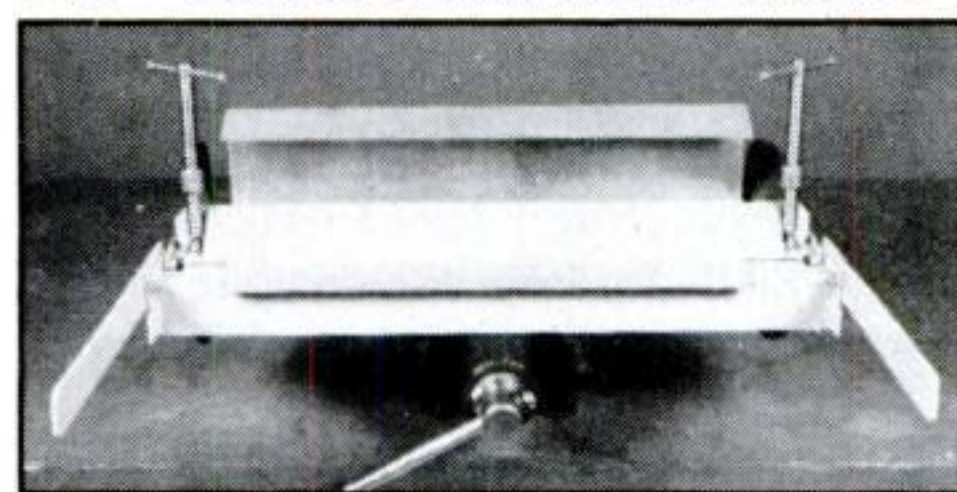
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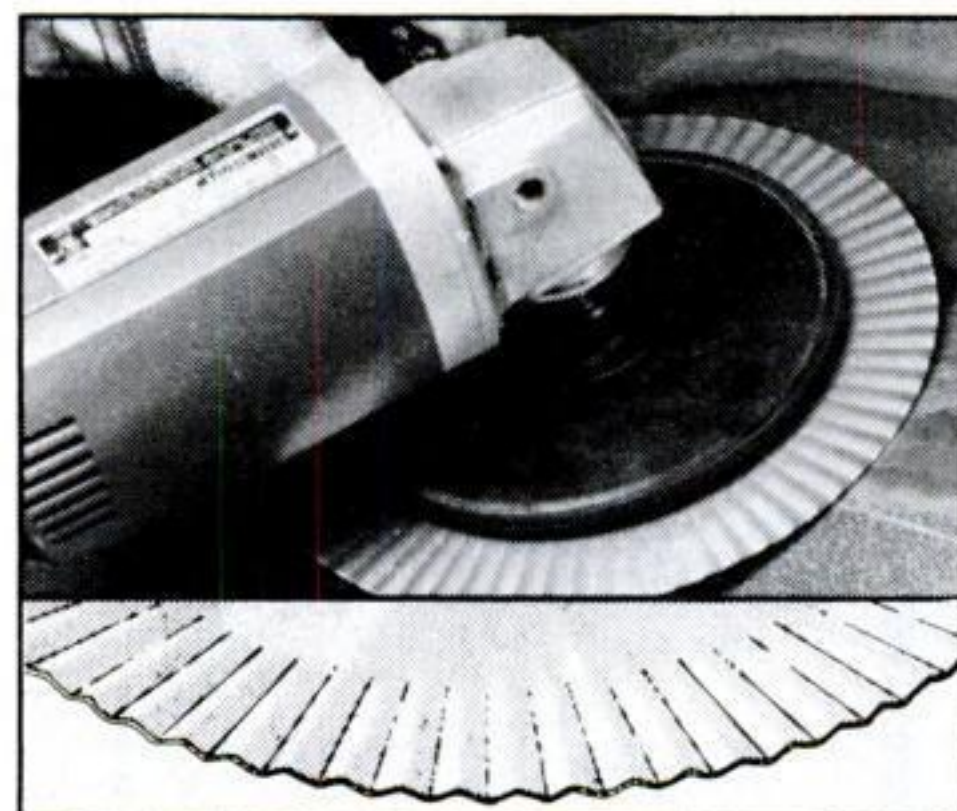
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6268 24" brake \$49.95
6271 Set of 2, 5" clamps \$14.75

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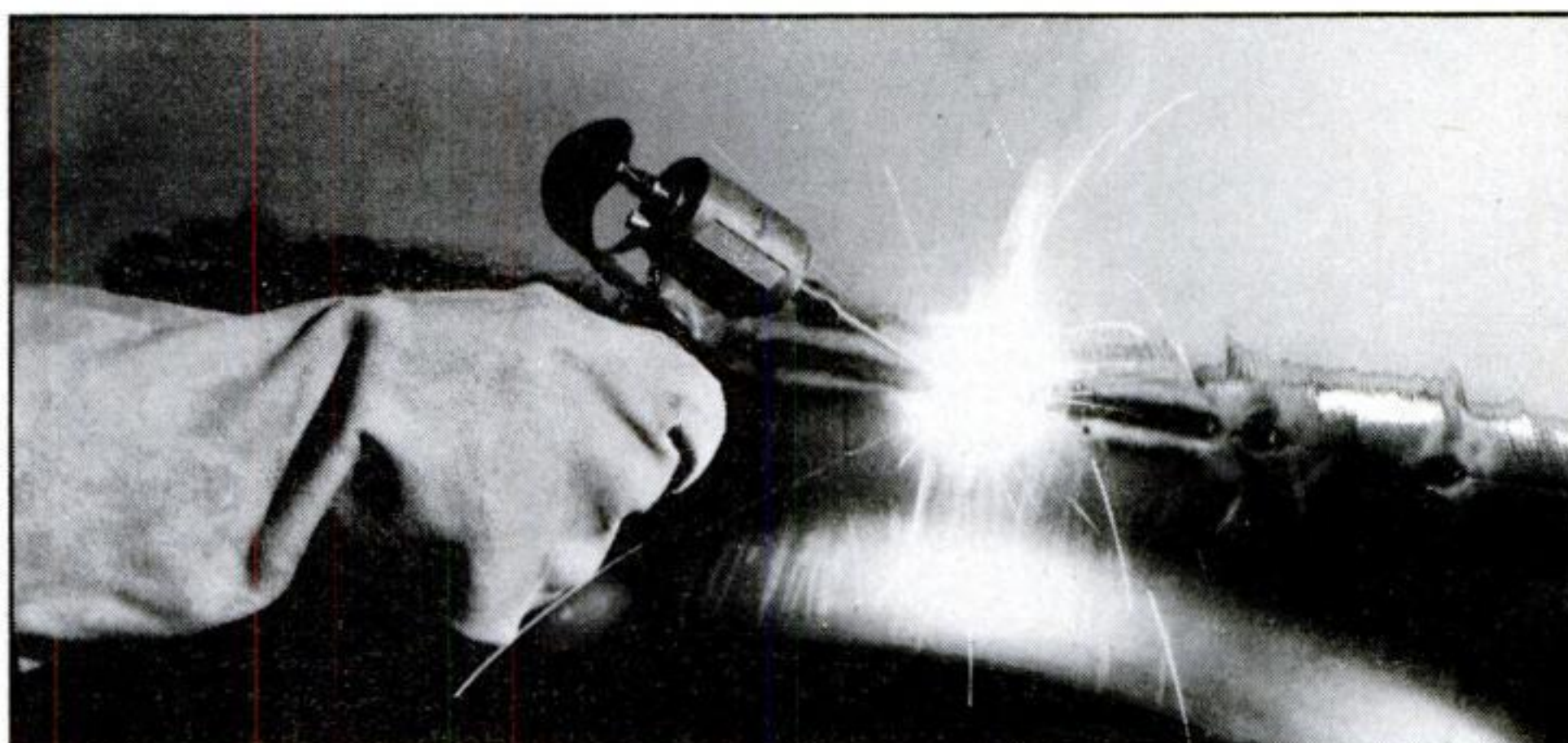


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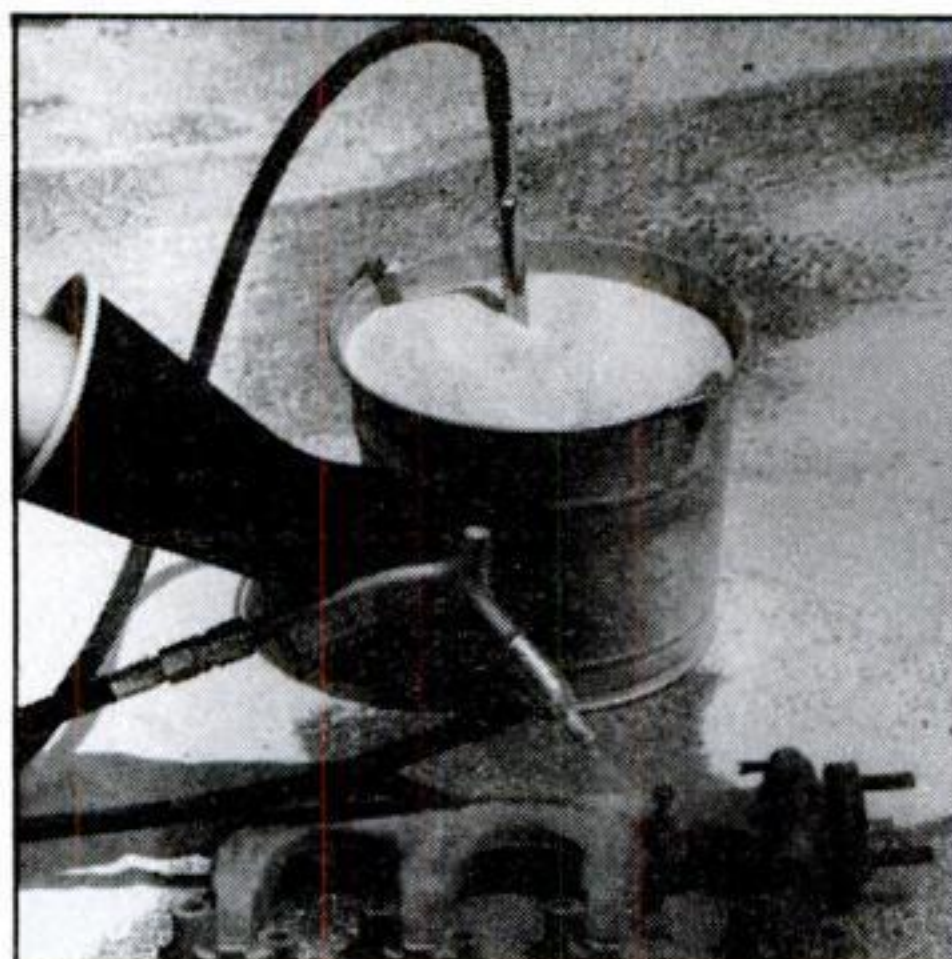
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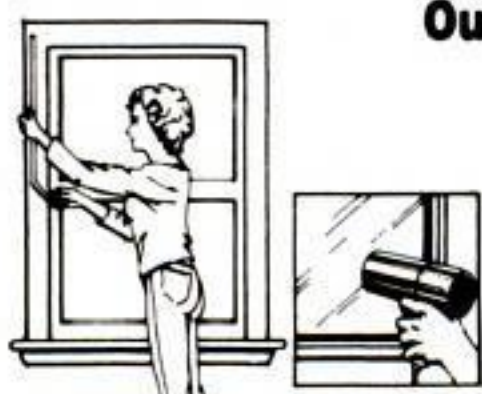
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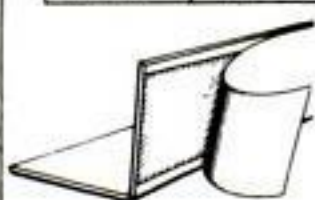


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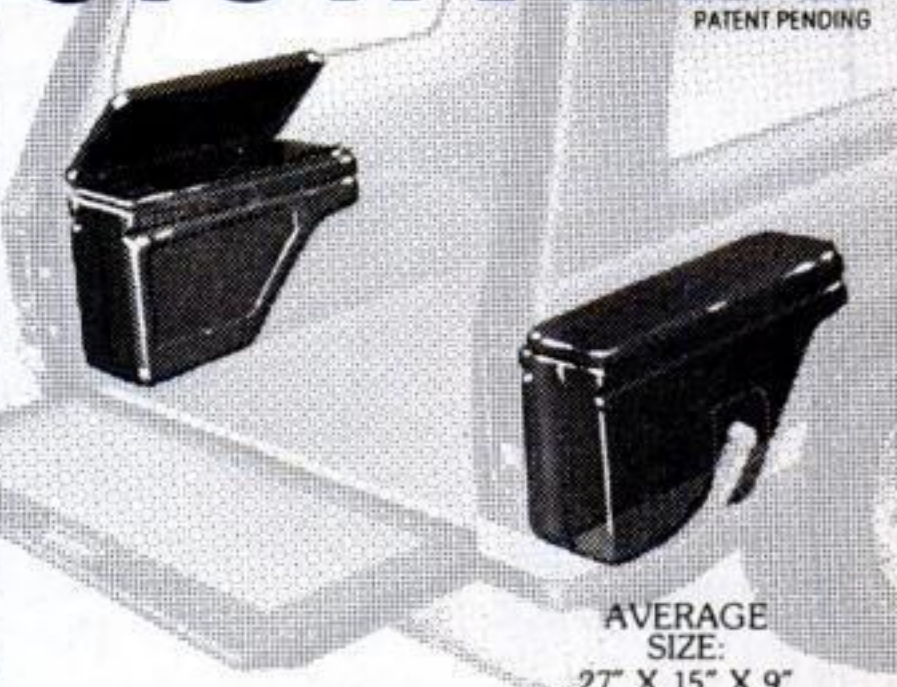
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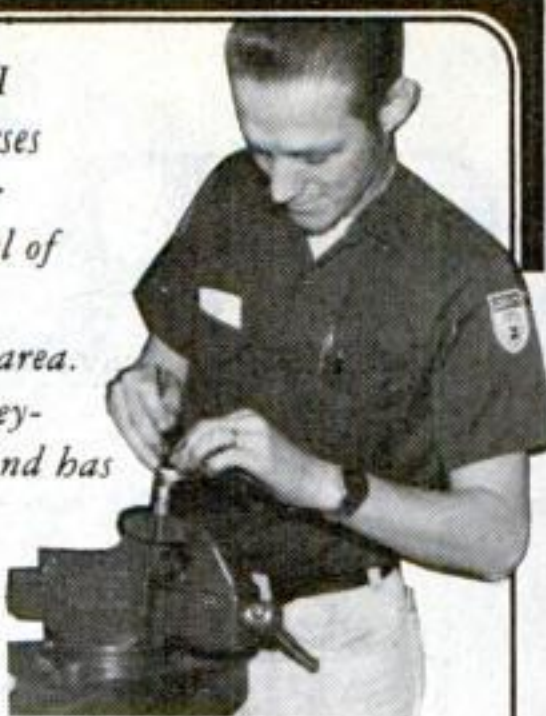


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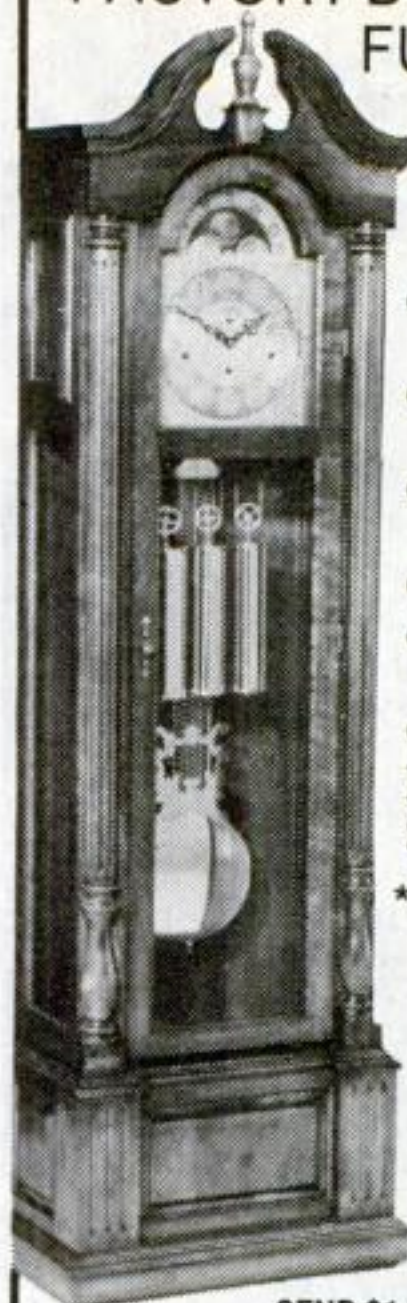
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PRESS RELEASE

The Platinum GaSaver installs in a matter of minutes and works effectively on all gasoline engines. Cars, trucks, motorhomes, boats and even implements using gasoline engines all can achieve a 22 to 40% increase in fuel efficiency with the use of this device. The manufacturer guarantee at least a 22% increase in actual gas mileage.

Even with a properly tuned engine, nearly a third of the gasoline it consumes is not burned. That unburned gas creates carbon deposits that shorten engine life, interfere with proper combustion and cause pings and knocks. And then the auto manufacturers attempt to solve the problem by using a catalytic converter to consume the unburned gasoline in the exhaust system before it returns to the atmosphere.

On February 28, 1984, four years of administrative procedures were completed by the Consumer Protection Department of the U.S. Government reviewing this process.

The government's conclusions? That National FuelSaver Corporation invented and markets a product called (Platinum) GaSaver which brings about more complete combustion and better gas mileage in automobile engines by means of platinum catalysis. That the (Platinum) GaSaver offers up to 30 percent fuel savings when applied properly to a gasoline engine. And that independent testing parties make stronger claims for (Platinum) GaSaver than does National FuelSaver Corporation.

The device takes only minutes to install on an automotive engine and allows 90 percent rather than the normal 60 percent of the gasoline in the combustion chamber to be burned during the power stroke. That means more power is developed by a given amount of gasoline. The device works on both leaded and unleaded gasoline, and meets or exceeds Environmental Protection Agency and California emission standards.

Federal Judge Walter Jay Skinner concluded a five-year administrative procedure studying the device by stating, "Independent testing shows greater fuel savings with the GaSaver than the 22 percent claimed by the developer."

The gas-saving system was tested by the Concord-Carlisle Regional School District in Massachusetts, which installed the devices on a fleet of 26 school buses and cars equipped with V-8 engines.

"We've been pleased with the results," Francis D. Curran, transportation manager for the school district, concluded. The fleet has averaged a 20 percent increase in gas mileage, as well as an improvement in cold weather engine starts.

Reprinted with permission from **The Albuquerque Tribune**

Device increases gas mileage by 22% to 40%

On July 11th, the government awarded National FuelSaver Corp. \$22,000 for developing a simple automotive accessory that increases gas mileage by 22 percent.

Called the Platinum GaSaver, it injects microscopic quantities of platinum into the airstream entering the engine.

The Injector itself takes only minutes to install, while the platinum entering the engine increases the percentage of each gallon burning in the engine from the normal 68 percent to 90 percent.

Normally, that 22 percent would only burn when it came in contact with the platinum-coated surfaces of the catalytic converter. But with the GaSaver introducing the platinum into the engine, platinum catalysis can now burn that fuel in the engine where the release of that heat and energy is harnessed to drive that vehicle.

With 22 percent more of each gallon burning in the engine, 22 percent fewer gallons are required.

The process works on both leaded and unleaded gasoline, and meets EPA and California standards.

Federal Judge Walter Jay Skinner concluded the five-year administrative procedure studying the GaSaver by stating, "Independent testing shows greater fuel savings with the GaSaver than the 22 percent claimed by its developer, National FuelSaver Corp."

In another study concluded recently, the government confirmed that the Platinum GaSaver raises the octane of gasoline, eliminating the need for premium gasoline.

Joel Robinson, the developer, commented, "We've already sold over 70,000 GaSavers. Ironically, we find more people buying the GaSaver for its third benefit of extending engine life, than buy it for fuel savings or octane boosting. Ever since our economy became battered by OPEC in 1973, we were convinced it would be a small company like ourselves that would reverse the trend of higher fuel costs."

The Platinum GaSaver has passed a 4 year administrative study of the U.S. Government. And has a full money back guarantee.

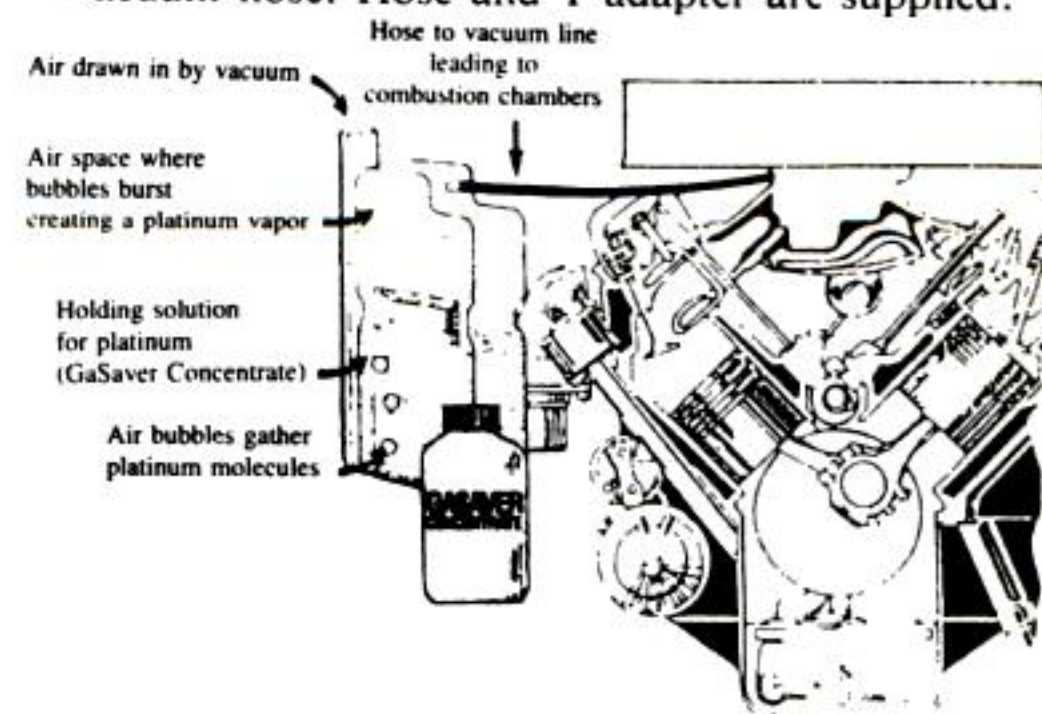
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In addition to the \$44,000 savings in fuel costs for the school district, the transportation manager notes that the real savings comes from reduced major engine repair on the buses as a result of cleaner burning engines that produce more power for the same amount of fuel.

In a press interview the developer states that the only problem the company has encountered is keeping up with the demand. With the heavy demand in the transportation industry and the ever increasing use in the farm community and now the news has spread of the tremendous benefits in recreational Vehicles, Motor Homes and Boats as well, we are working around the clock to keep the orders filled. At this time we are able to guarantee delivery within 3 weeks. But at the present growth rate, we can see considerably longer delivery times in the near future.

How the Platinum GaSaver System Works

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Government awards \$22,000 for development of a simple device that increases fuel efficiency 22 to 40%

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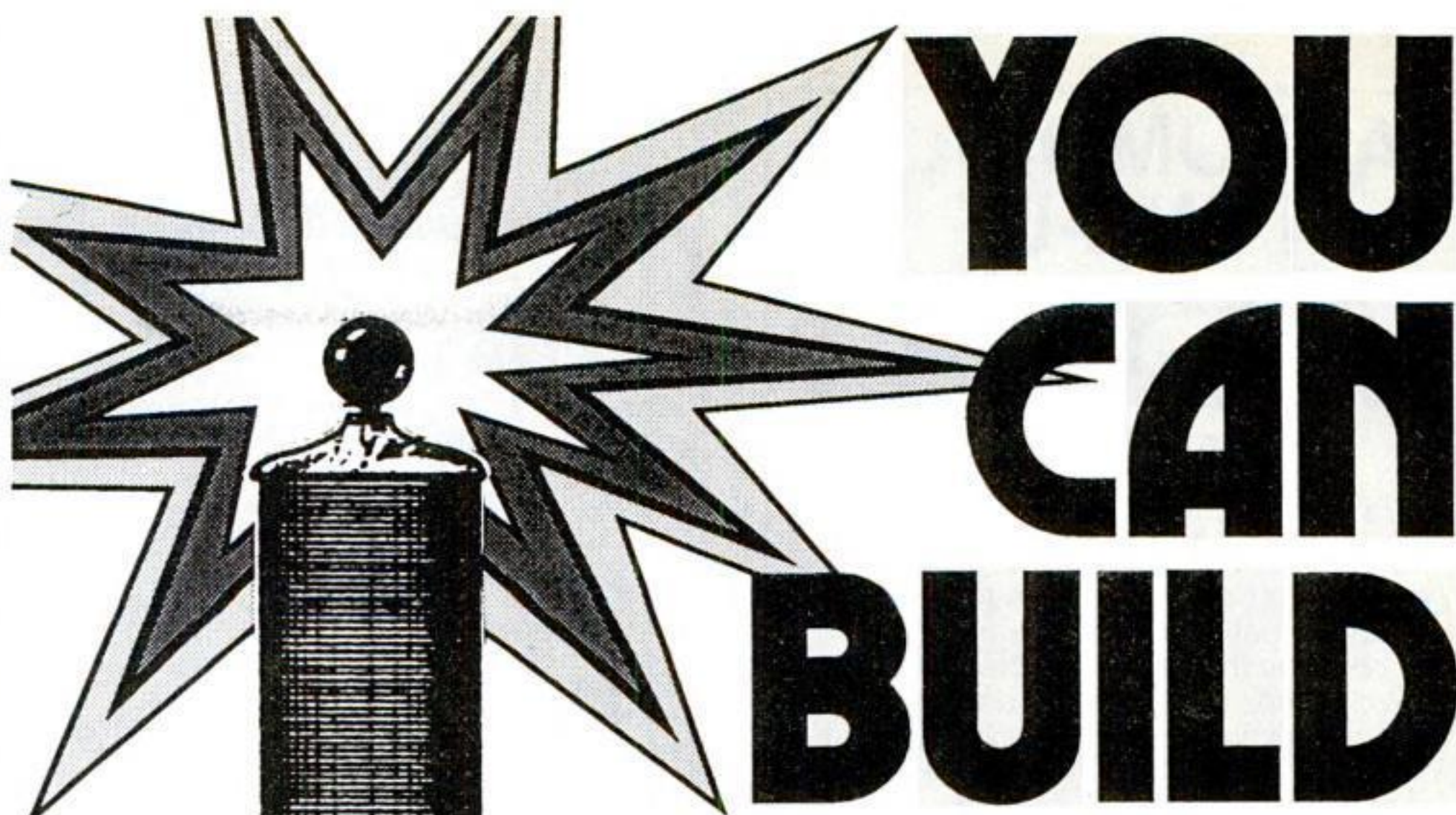
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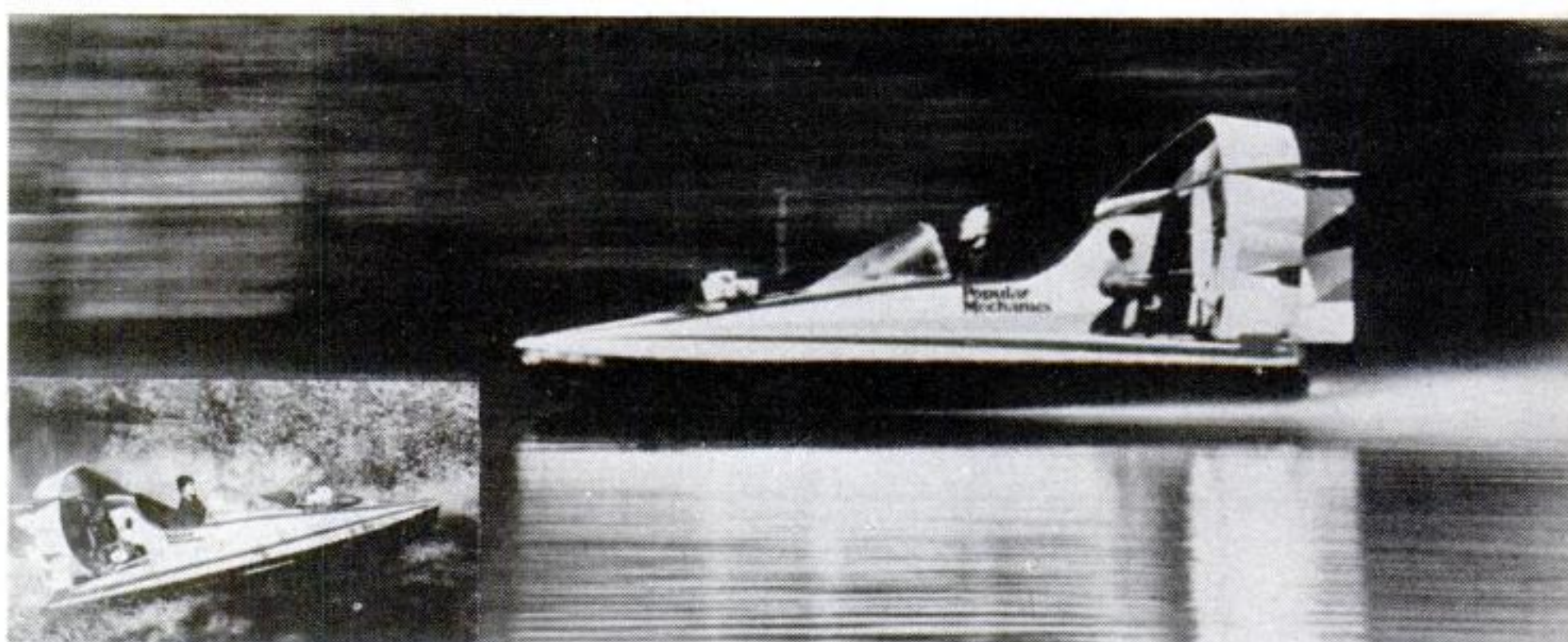
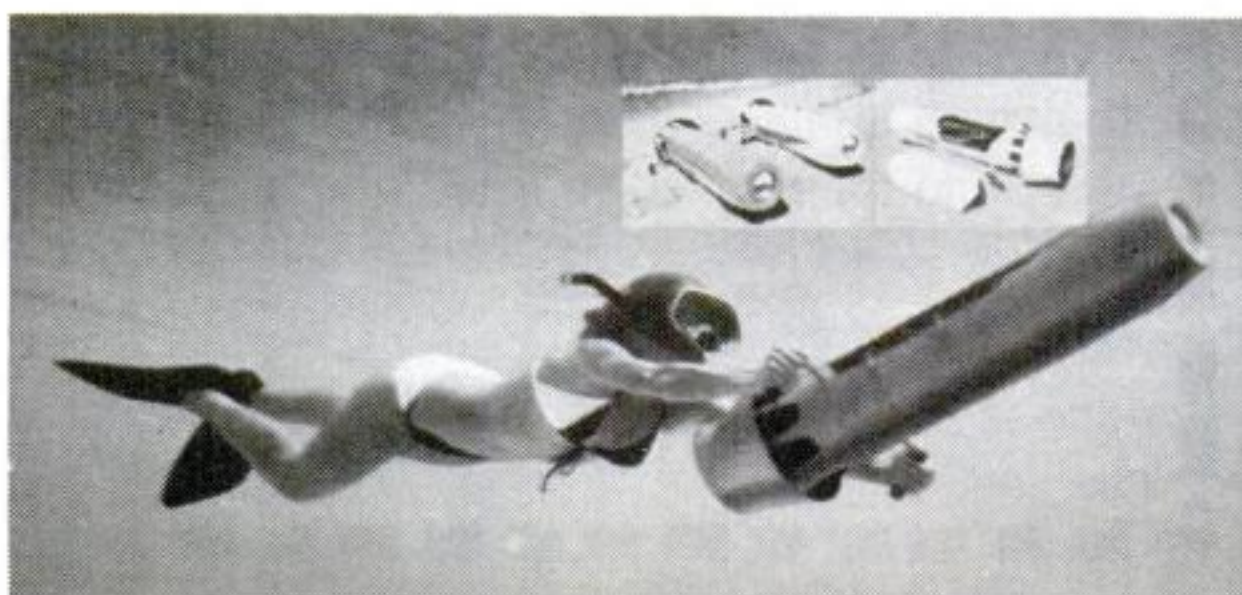
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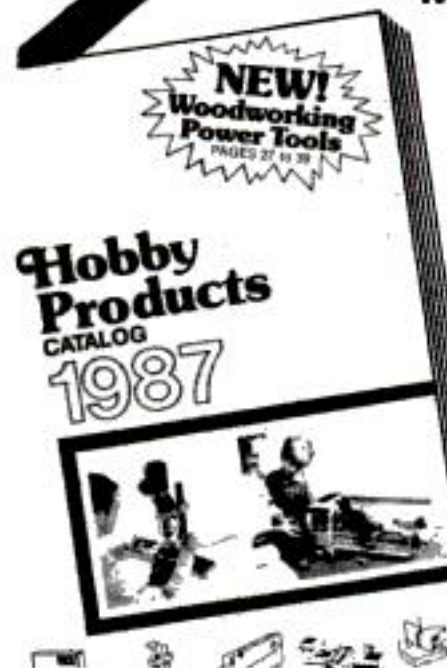
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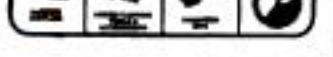


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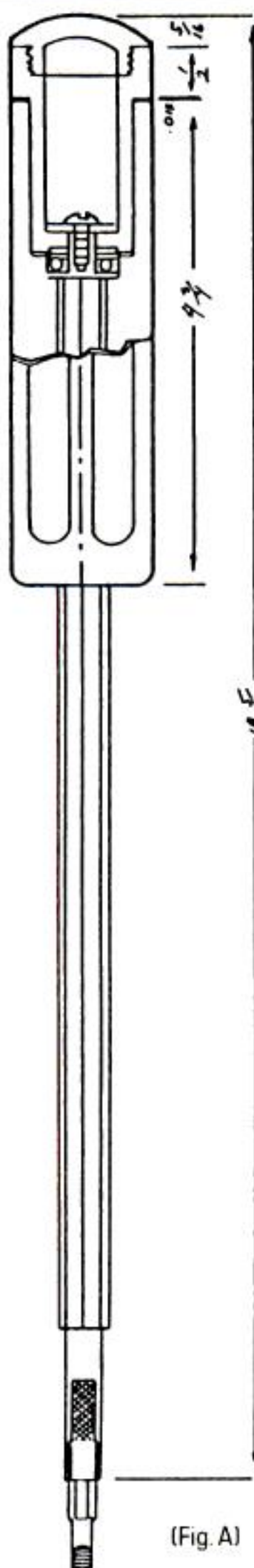
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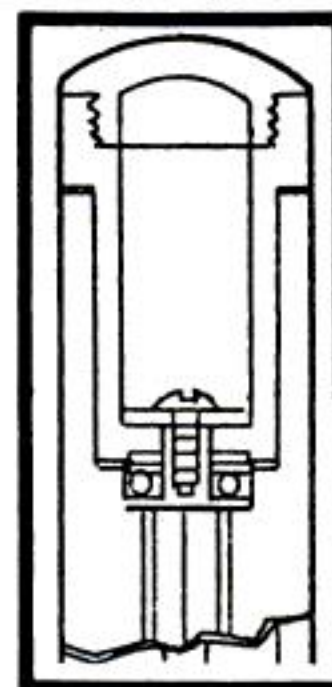
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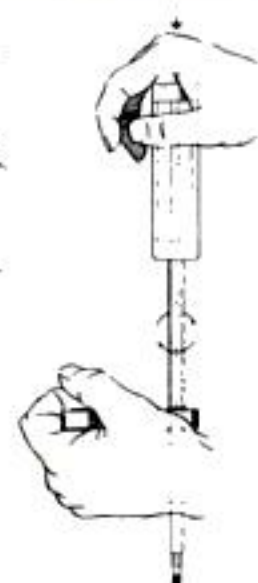
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(Fig. A)



(Fig. B)



(Fig. C)

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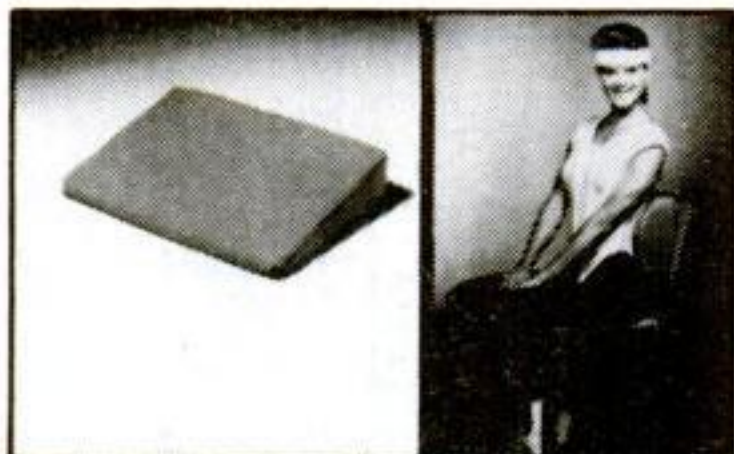
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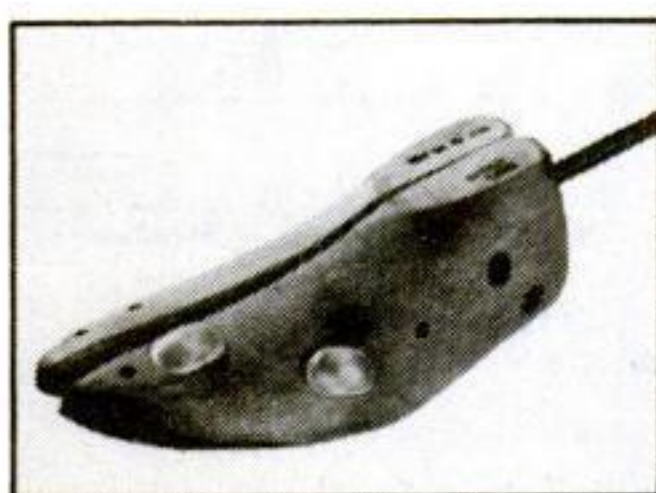
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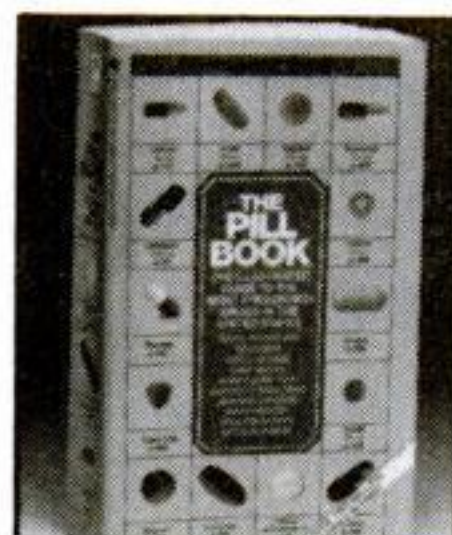
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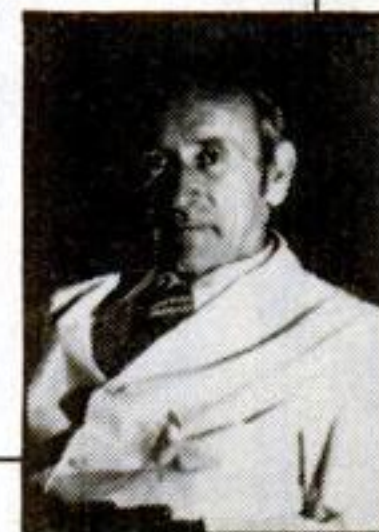
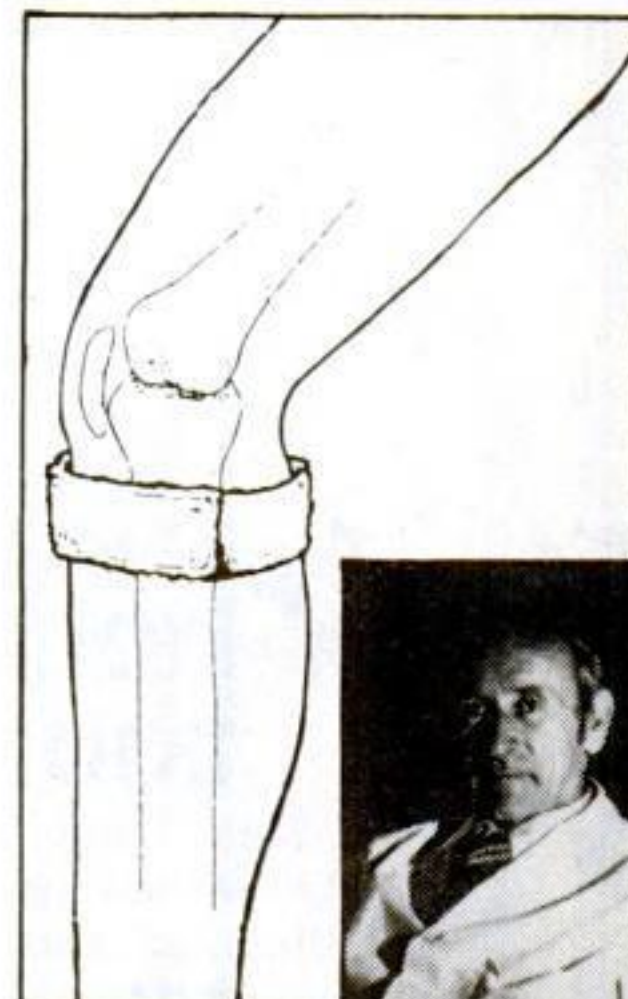
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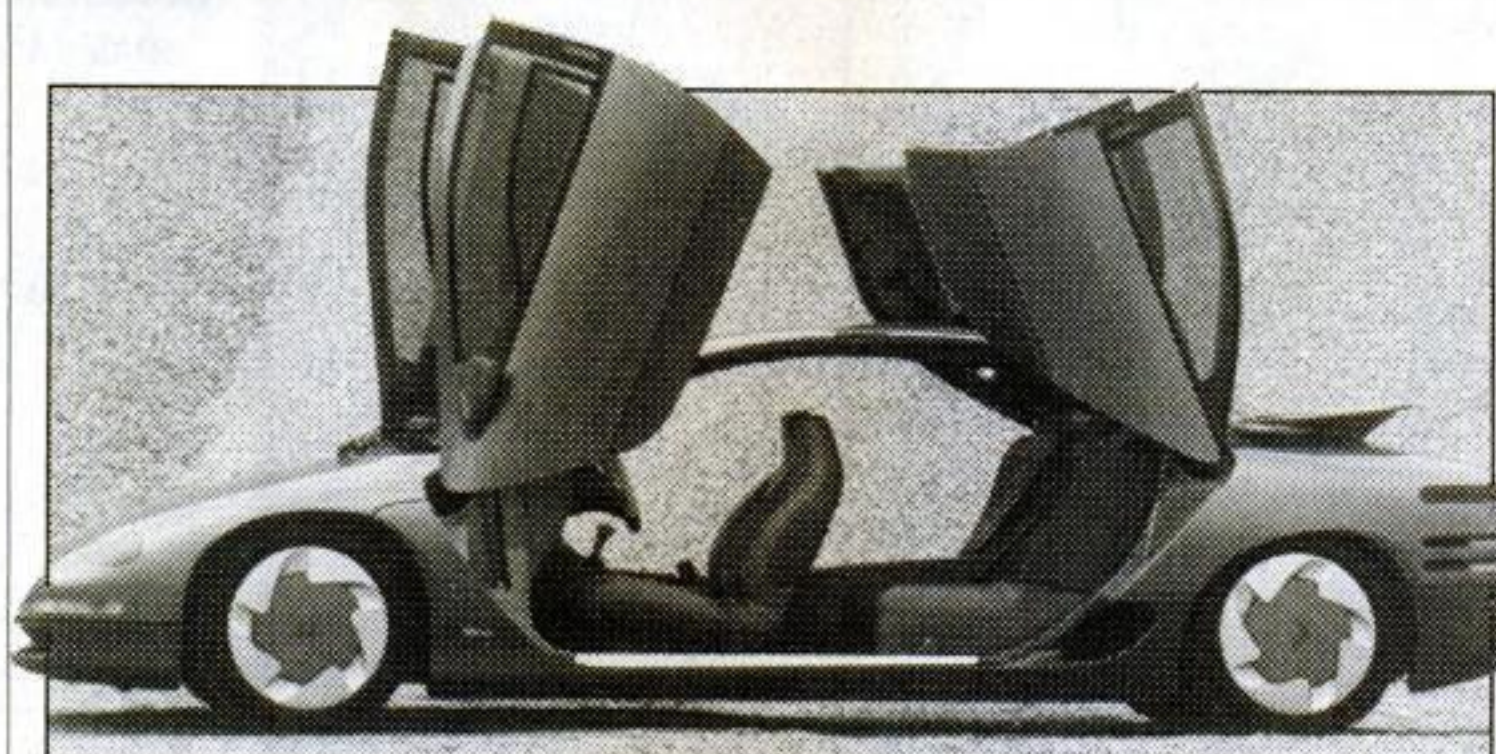


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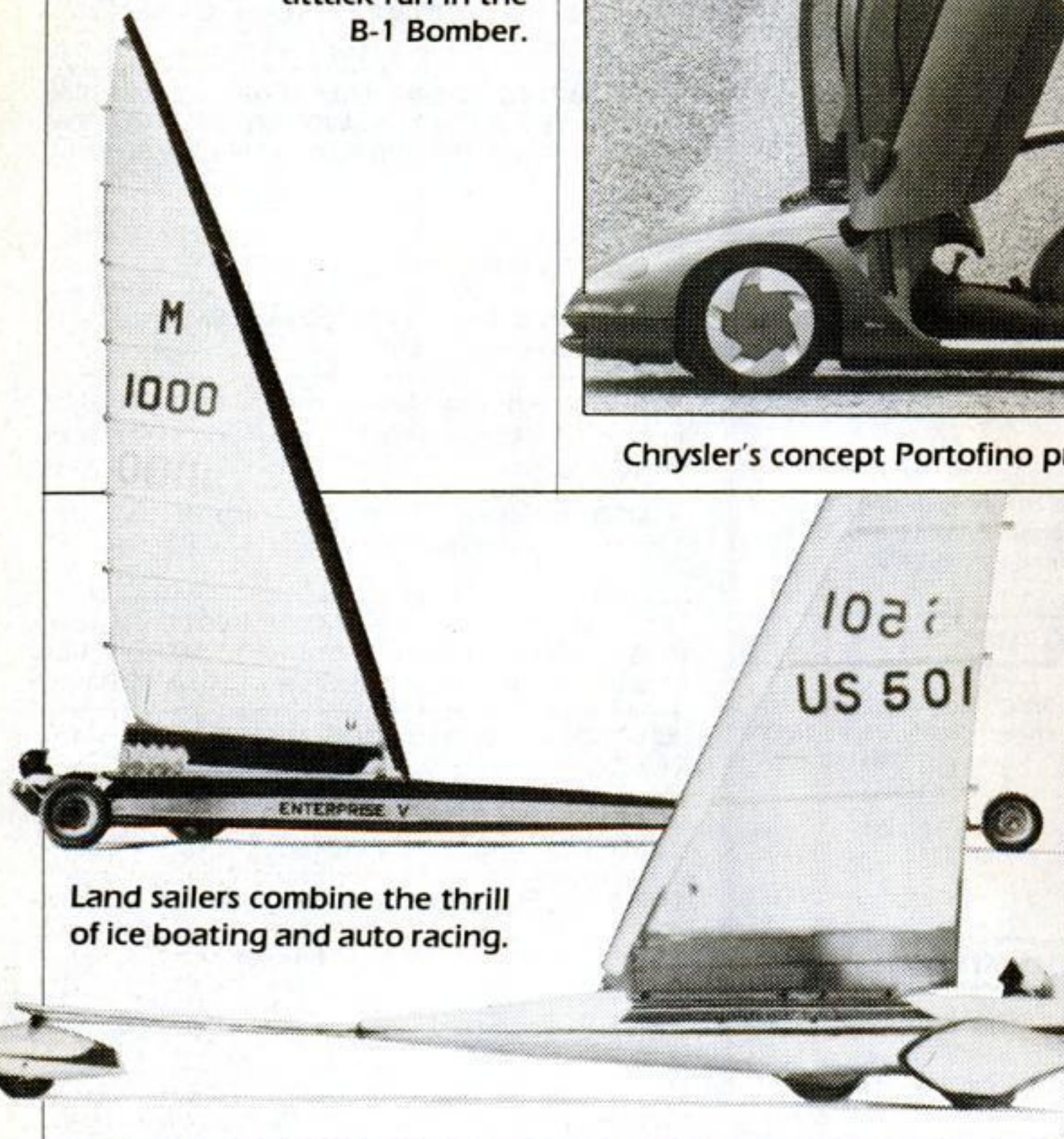


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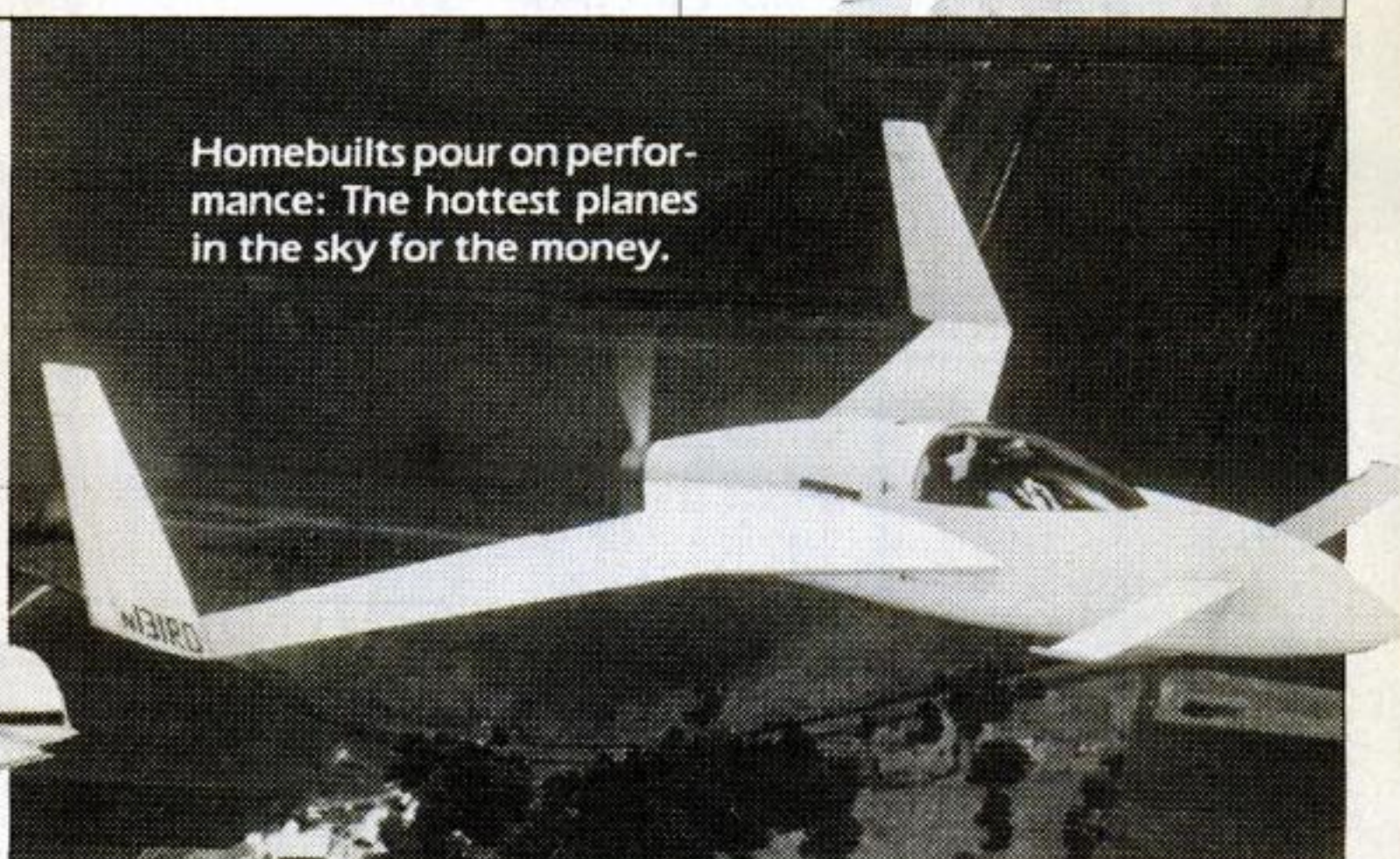
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